Miocene Bryozoa from East Kalimantan, Indonesia. Part II: 'Ascophoran' Cheilostomata

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We describe 72 ascophoran-grade cheilostomes, ranging in age from Early to Late Miocene (late Burdigalian to Messinian), collected from 17 sections in the vicinities of Samarinda, Bontang and Sangkulirang in East Kalimantan, Indonesian Borneo. Two genera (*Oviexechonella* gen. nov. and *Sendinopora* gen. nov.) and twenty species (?*Filaguria kalimantanensis* sp. nov., *Puellina bontangensis* sp. nov., *Caberoides gordoni* sp. nov., *Trypostega hasibuani* sp. nov., *Oviexechonella digeronimoi* sp. nov., *Reptadeonella curvabilis* sp. nov., *Reptadeonella toddi* sp. nov., ?*Hippomenella devatasae* sp. nov., ?*Hippomenella uniserialis* sp. nov., *Margaretta amitabhae* sp. nov., *Hippopodina indicata* sp. nov., *Saevitella renemai* sp. nov., *Gigantopora milenae* sp. nov., *Arthropoma renipora* sp. nov, *Bryopesanser bragai* sp. nov., *Bryopesanser sanfilippoae* sp. nov., *Tubiporella magnipora* sp. nov., *Buffonellaria sagittaria* sp. nov., *Lagenipora sciutoi* sp. nov. and *Sendinopora prima* sp. nov.) are new. Ten species show affinities with Recent taxa from the Indo-Pacific; two species show similarities with Recent species recorded circumtropically; and three species were known previously from the Neogene of Europe, Australia or India.

Contents

Introduction

The Cenozoic bryozoan fauna of Indonesia has been severely neglected in the past, leading to the mistaken belief that bryozoans are rare and of low diversity. Under the auspices of the European Community Project 'Throughflow', new material has been collected in East Kalimantan (Indonesian Borneo), from 17 Early to Late Miocene sites located in the Kutai Basin, in the vicinities of Samarinda, Bontang and Sangkulirang. Moderately well preserved bryozoans are found mainly encrusting the undersides of platy corals or as fragments of erect colonies and free-living species scattered through the muddy-silty sediments.

This paper represents the second part of a monograph containing a detailed systematic description of the bryozoan fauna from the Miocene of East Kalimantan. The first part (Di Martino & Taylor, 2014) included geological and stratigraphical descriptions of the studied sections, materials and methods, and systematic descriptions of

51 bryozoan species, comprising 15 cyclostomes and 36 anascan-grade cheilostomes. This second part provides systematic descriptions of 72 ascophoran-grade cheilostomes and a summary of the results of the systematic research.

Systematic palaeontology

Order Cheilostomata Busk, 1852
Infraorder Ascophorina Levinsen, 1909
Superfamily Cribrilinoidea Hincks, 1879
Family Cribrilinidae Hincks, 1879
Genus *Antoniettella* Di Martino & Taylor, 2012a

Antoniettella exigua Di Martino & Taylor, 2012a
Pl. 1.

Figured material – Holotype: NHMUK PI BZ 5842, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony encrusting, multiserial, unilaminar or often multilaminar, with up to four layers of zooids, each layer thick; size typically small, only a few mm in diameter, approximately circular in outline. Autozooids angular in outline shape, pentagonal or hexagonal, enlarging progressively during astogeny from the periancestrular zone to the edge of the colony, with the ratio of length to width increasing. Frontal shield slightly convex, usually composed of 8 to 10 prominent costae, rarely 11 costae; intercostal lacunae and costal lumen pores not visible. Two or three oval communication pore windows (mean L = 40 μm and mean W = 15 μm) along distolateral vertical walls, sometimes visible along the margins of zooids at the colony growing edge. Primary orifice longer than wide, a pair of rounded shallow condyles directed downwards and separating a horseshoe-shaped anter from a smaller poster that has a broad U-shaped sinus with a nearly straight or slightly convex proximal edge. Orifice surrounded by a low peristome, higher distally. Oral spines articulated, represented by spine bases only, diameter 20 μm, number uncertain, some zooids showing only three or four, but as many as eight in others, arranged in an arc around the distal edge of the orifice. One or two small oval or subcircular structures sometimes present distolateral to the orifice may be polymorphs, probably kenozooids but possibly adventitious avicularia. Ancestrular characters unclear, a single distal zooid seemingly budded from the ancestrula. Periancestrular zone formed by 5 or 6 small zooids. Ooecia not observed, presumed to be lacking.

Measurements – ZL 410±22, 399-454 (5, 40); ZW 450±18, 430-485 (5, 40); OL 160±5, 150-170 (5, 40); OW 120±12, 100-140 (5, 40).

Remarks – Colonies of *Antoniettella exigua* were found associated with scleractinian corals, encrusting both platy genera such as *Echinopora*, *Pachyseris* and *Fungophyllia*, and, less often, branching genera of Acroporidae. The species was firstly described from a section dated at the Burdigalian-Langhian boundary where it was the most

common and abundant taxon. Recently a few specimens have been also found in late Burdigalian, Serravallian and Messinian strata, but unfortunately their preservation is still poor, not allowing clarification of some doubtful features such as the kind of polymorphs located disto-lateral to the orifice, and the exact number of oral spines.

Genus *Filaguria* Moyano, 1991

?*Filaguria kalimantanensis* sp. nov.

Pl. 2.

Figured material – Holotype: NHMUK PI BZ 6900, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Etymology – Named after the Indonesian region of Borneo, Kalimantan, at present its unique geographical record.

Diagnosis – Colony encrusting. Autozooids oval. Gymnocyst smooth, convex, extensively developed proximally. Frontal shield consisting of 19-22 costae. Uncalcified pelmatidium located two-thirds along costa. Orifice rounded D-shaped with slightly concave proximal margin with short rounded condyles, bearing two oral spine bases. ?Vicarious avicularia with 14 costae. Ooecium oval with two drop-shaped frontal fenestrae.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not observed. Autozooids distinct with deep interzooidal furrows, arranged quincuncially, oval, longer than broad (mean L/W = 1.75). Gymnocyst smooth and convex, extensively developed proximally, occupying about one-third of the zooidal length, tapering laterally, reduced distally. Frontal shield convex, consisting of 19-22 costae, most commonly 19, mean width 35 μm and length 110 μm, fused medially and along the edges, and separated along their length by several small circular lacunae (Fig. 1b). One small, uncalcified pelmatidium usually located two-thirds along the surface of each costa. Orifice slightly longer than broad, anter D-shaped, separated from concave poster by small rounded condyles; one oral spine base located on each side proximal to the orifice at condyle level. ?Vicarious avicularia (Fig. 1c) similar to autozooids in size and shape, differing in having a costate frontal shield with 14 costae, the first three pairs broader than the rest, and a tongue-shaped rostrum with a 260 μm long aperture that is broader proximally (*c.* 160 μm), and narrower distally (*c.* 140 μm), two thick rounded condyles directed downwardly. Ooecium hyperstomial, transversely elongate, broadening distally, about 180 μm long and 300 μm wide, with an elongate, drop-shaped, transverse frontal fenestra on each side. Kenozooids not seen.

Measurements – ZL 700±67, 618-802 (1, 15); ZW 400±20, 354-423 (1, 15); OL 157±4, 155-160 (1, 10); OW 142±11, 127-156 (1, 10).

Remarks – A single specimen, found encrusting the base of a platy coral identified as *Pachyseris* sp. in one of the Serravallian sections, has been tentatively referred to the

genus *Filaguria* because of the ambiguous presence of a 'primitive' avicularium, which is the main diagnostic feature of the genus (Moyano, 1991). The preservation of the colony does not allow elimination of the possibility that this zooid is instead an autozooid with a broken frontal shield and orifice that is squeezed in-between normally shaped zooids, although the tapered distal part supports its identification as a vicarious avicularium.

The genus *Filaguria* includes two Recent species, *F. spatulata* (Calvet, 1909) and *F. lithocrustata* Branch & Hayward, 2005, the former species with a wide Antarctic distribution, the latter reported from Marion Island in the South Indian Ocean at depths of 160 to 775 m. The Kalimantan species differs from both in having a much more extensive gymnocyst and fewer oral spines.

Genus *Puellina* Jullien, 1886

Puellina cf. *voigti* (Ristedt, 1985)

Pl. 3.

cf. *Cribrilaria voigti* Ristedt, 1985, p. 22, fig. 4a-f.
cf. *Puellina voigti* Tilbrook, 2006, p. 96, pl. 15, figs. C-D.

Figured material – NHMUK PI BZ 6901, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and basal pore windows not seen. Autozooids small, suboval or subhexagonal, slightly broader than long (mean L/W = 1.05), distinct, with deep interzooidal furrows, irregularly arranged. Gymnocyst inconspicuous, developed around periphery of autozooids. Frontal shield formed by 17-21 fused costae with 5-7 intercostal lacunae. Apertural bar thickened medially; suborificial lacuna not observed. Orifice transversely D-shaped, broader than long, bearing six evenly spaced oral spine bases, four in ovicellate zooids. Ooecium globular, smooth, slightly broader than long, resting on the proximal frontal shield of the next distal autozooid (apparently Type A *sensu* Bishop & Household, 1987), with a median suture (Fig. 1b, c). Avicularia interzooidal, frequent; cystid well developed (mean L = 370 μm, mean W = 250 μm), rhomboidal, with broad, convex, smooth gymnocyst; rostrum parallel-sided proximally, expanded distally into an uncertain number of projections, but at least three, directed along the side of an adjoining autozooid (Fig. 1d). Kenozooids infrequent, same size as autozooids; gymnocyst minimal around the kenozooidal margins; frontal shield formed by numerous fused costae, lacking orifice.

Measurements – ZL 350±39, 303-395 (3, 60); ZW 369±19, 348-399 (3, 60); OL 62±12, 49-74 (3, 60); OW 90±15, 75-112 (3, 60); AL 195±9, 184-200 (3, 15); OvL 139±11, 127-148 (3, 9); OvW 160±3, 157-162 (3, 9).

Remarks – *Puellina* cf. *voigti* is common in late Burdigalian to Serravallian strata, in which it forms extensive sheet-like colonies on the bases of platy scleractinian corals. Preservation is variable, with the frontal shield commonly crushed, precluding obser-

vation of any suborificial lacunae potentially present on the apertural bars. Also, the number of projections of the tip of the rostrum is unclear owing to erosion. These problems are the main uncertainities about the attribution of the Kalimantan species to Recent *Puellina voigti*, which has been recorded from shallow waters in the Philippines (0.5-5 m) (Ristedt, 1985; Scholz, 1991) and the Solomon Islands (Tilbrook, 2006). In addition the Kalimantan specimens have smaller autozooids and different proportions of length and width in both autozooids and ooecia. In fact for specimens from the Philippines, Ristedt (1985) reported a maximum size of 0.45 × 0.60 mm, while the autozooids in the single specimen found by Tilbrook (2006) at Yandina, Mbanik Island, were 0.45 mm long and 0.30 mm broad, compared with an average of 0.35 × 0.37 mm for the Kalimantan material.

***Puellina bontangensis* sp. nov.**

Pl. 4.

Figured material – Holotype: NHMUK PI BZ 6902, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after its type locality, Bontang.

Diagnosis – Colony encrusting. Pore chambers present around autozooidal and kenozooidal margins. Autozooids suboval or subhexagonal. Gymnocyst minimal. Frontal shield formed by 15-26 fused costae. Triangular suboral area with a circular lacuna and a small umbo. Orifice semicircular bearing seven oral spine bases, four in ovicellate zooids. Ooecium with a small proximal tubercle. Avicularia interzooidal and adventitious, triangular. Kenozooids frequent.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula subcircular, about 100 μm in diameter, tatiform with nine spine bases visible, the central part filled by the collapsed frontal shield of an intramurally budded autozooid (Fig. 1b), surrounded by five autozooids, the first distal bud much smaller than later ones, about 170 μm long by 115 μm wide. Pore chamber windows visible at the colony growing edge, placed all around the autozooidal and kenozooidal margins, oval, small, mean length 30 μm and width 15 μm, closely spaced (Fig. 1d). Autozooids suboval or subhexagonal, longer than broad (mean L/W = 1.31), distinct, with deep interzooidal furrows, quincuncially arranged (Fig. 1c). Gymnocyst smooth, convex, broader proximally, minimal around the rest of autozooid. Frontal shield formed by 15-26 fused costae, most commonly twenty, with 7-10 intercostal lacunae. First pair of short costae bounding a triangular suboral area with a circular lacuna and forming a small umbo in midline. Orifice semicircular, slightly broader than long, bearing seven, small (mean D = 5 μm), closely spaced, oral spine bases, four in ovicellate zooids. Ooecium globular, smooth, slightly broader than long, resting on the proximal frontal shield of the next distal autozooid (apparently Type A *sensu* Bishop & Household, 1987) with a small proximal tubercle. Interzooidal avicularia semi-pedunculate, arising from the junction between three autozooids or kenozooids, slender, mean length 170 μm, with a long rostrum distolaterally directed, resting on the frontal shield of the next distal autozooid (Fig. 1c, d). A pair

of small (mean length 100 μm), triangular, adventitious avicularia associated with the lateral ooecium margin, with pointed rostrum and serrated lateral edges, distally directed (Fig. 1e). Kenozooids frequent, interzooidal or at the colony edge, variable in size and shape, with a narrow border of smooth gymnocyst and frontal shield formed by numerous fused costae, lacking orifice.

Measurements – ZL 420±45, 338-476 (2, 50); ZW 321±35, 290-400 (2, 50); OL 63±3, 60-65 (2, 20); OW 74±6, 67-78 (2, 20); OvL 126±8, 118-141 (2, 20); OvW 151±7, 140-161 (2, 20).

Remarks – *Puellina bontangensis* sp. nov. is common in the late Burdigalian to Serravallian, where it forms, often associated with *Puellina* cf. *voigti*, extensive sheet-like colonies on the bases of platy scleractinian corals. As in *Puellina* cf. *voigti* the frontal shield is commonly crushed.

Four Recent tropical species of *Puellina* with seven oral spines have been described: *P. africana* (Hayward & Cook, 1983), *P. harmeri* (Ristedt, 1985), *P. vulgaris* Ryland & Hayward, 1992, and *P. septemcryptica* Dick, Tilbrook & Mawatari, 2006. *Puellina bontangensis* sp. nov. differs from all of these in having larger zooids and a frontal shield formed by a greater number of costae. *Puellina africana* shows similar adventitious avicularia at the lateral ooecium margin, but is distinct in having autozooids with a triangular suboral area with up to five large pores. *Puellina harmeri* and *P. vulgaris* may be synonymous; Dick *et al.* (2006) pointed out that the distinction between these two species is unclear and based mainly on avicularium size which, however, falls within the range of intercolony variation. In addition to autozooidal size and number of costae, these species differ from *Puellina bontangensis* sp. nov. in the presence of more conspicuous suboral lacunae and five oral spines in ovicellate zooids. The final species, *P. septemcryptica*, differs also in having less frequent interzooidal avicularia, and in the absence of avicularia associated with the ooecium and kenozooids. No clear similarities are apparent between the Kalimantan species and other fossil species of *Puellina* described previously.

***Puellina* sp.**

Pl. 5.

Figured material – NHMUK PI BZ 6903, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and pore chamber windows not seen. Autozooids suboval or subhexagonal, longer than broad (mean L/W = 1.43), distinct, with deep interzooidal furrows, irregurlarly arranged (Fig. 1a). Gymnocyst inconspicuous. Frontal shield formed by 18-21 fused costae, with 6-8 intercostal lacunae. First pair of costae bounding a triangular suboral area; lacuna not visible. Orifice transversely D-shaped, slightly broader than long (Fig. 1d), bearing an uncertain number of oral spine bases, probably five. Ooecium helmet-shaped, smooth, slightly broader than long, resting on the proximal frontal shield of the next distal autozooid (apparently Type A *sensu* Bishop & Household, 1987) (Fig. 1a, d). Interzooidal avicularia with a slender, pointed, channelled rostrum, diagonally directed and adnate to the distal margin of a neighbouring zooid, placed on a subtriangular cystid

having a smooth, convex gymnocyst with a large circular pore (D = 40 μm), facing laterally (Fig. 1c). Kenozooids not observed.

Measurements – ZL 393±42, 307-451 (2, 40); ZW 275±22, 230-303 (2, 40); OL 62±6, 51-70 (2, 20); OW 82±6, 72-90 (2, 20); OvL 159±2, 158-161 (1, 2); OvW 168±2, 167-170 (1, 2); AL 286±25, 257-314 (2, 10).

Remarks – The presence of *Puellina* sp. is restricted to a section dated as Burdigalian-Langhian boundary. The uncertainty in the number of oral spine bases, due to the poor preservation of the few specimens found, make identification and comparisons difficult. However, the shape and orientation of the avicularia show some affinities with those of *Puellina scripta* (Reuss, 1848) from the Miocene of Austria (illustrated in Bishop & Househam, 1987, p. 58, figs. 98-99).

Superfamily Catenicelloidea Busk, 1852
Family Catenicellidae Busk, 1852
Genus *Caberoides* Canu, 1908

***Caberoides gordoni* sp. nov.**
Pl. 6.

Figured material – Holotype: NHMUK PI BZ 6904, late Burdigalian, TF126, '3D Reef', Bontang; Paratype: NHMUK PI BZ 6905, same details as holotype.

Etymology – Named after Dennis P. Gordon (NIWA, Wellington), in recognition of his significant contribution to the study of bryozoans.

Diagnosis – Colony erect, articulated. Autozooids subhexagonal. Frontal shield with two narrow lateral cryptocystal areas with a single series of pores. Gymnocystal median ridge Y-shaped. Suboral costal field below the orifice. Orifice with condyles separating a rounded anter from a V-shaped poster. Single avicularium on the outer distal side of the orifice. Dorsal side with a narrow vibraculum-like chamber.

Description – Colony erect, articulated with biserial branches. Internodes up to 2.60 mm long and 0.40 mm wide, comprising as many as 12 regularly alternating zooids facing frontally (Fig. 1a). Autozooids distinct with deep interzooidal furrows, subhexagonal, elongated (mean L/W = 2.33), tapering towards the proximal end (Fig. 1b). Frontal shield with two narrow cryptocystal areas, each with a sinuous single longitudinal series of circular septular pores along its length and around the distal side of the orifice, separated by a Y-shaped median ridge of smooth depressed gymnocyst (Fig. 1b). A tiny suboral costal field immediately below the orifice, with a pair of vestigial costae between the arms of the Y. Narrow gymnocystal border present also around orifice and avicularium. Orifice slightly longer than broad with two small rounded condyles separating a large rounded anter from a smaller deep, flared V-shaped poster, often closed by a calcified operculum, smooth with a proximal bend (Fig. 1c, d). Ooecium not seen. Single avicularium, always on the outer distal side of the orifice, distally directed,

facing laterally, triangular, with complete cross-bar, raised beak-shaped rostrum, curved proximally (Fig. 1c). Dorsal side with a narrow vibraculum-like chamber extending from behind each avicularium obliquely across the width of the zooid to the midline of the segment, and a narrow depressed curved cryptocystal area, with a single series of septular pores surrounded by smooth, convex gymnocyst (Fig. 1e-g).

Measurements – ZL 422±21, 384-445 (3, 30); ZW 181±22, 167-232 (3, 30); OL 80±5, 74-85 (3, 15); OW 69±4, 64-73 (3, 15); AL 62±5, 54-66 (3, 15).

Remarks – This species is rare and restricted to the late Burdigalian. None of the five internodes found is fertile. Attribution to *Caberoides* instead of the closely related *Ditaxipora* MacGillivray, 1895, is based on the presence of the vestigial suboral costal field and the vibraculum-like chamber, extending behind each avicularium, on the dorsal side. Five species of *Caberoides* are known from the fossil record: *C. rockallensis* Gordon & Braga, 1994, from the Paleocene of the North Atlantic, and *C. canaliculata* and *C. grignonensis* Canu, 1908, from the Eocene of France, *C. continua* (Waters, 1891) and *C. miranda* Gordon & Braga, 1994, from the Eocene of Italy and New Zealand, respectively. The new species differs from *C. miranda* and *C. rockallensis* in having only two cryptocystal frontal areas instead of four or five; from *C. canaliculata* in having much more slender internodes, with longer and narrower zooids (mean L/W = 0.95 in *C. canaliculata* vs 2.33 in *Caberoides gordoni* sp. nov.), and a dorsal side with a shorter vibraculum-like chamber and a narrower cryptocystal area with septular pores arranged in a single linear series instead of being irregularly scattered; from *C. grignonensis* in having narrower and shorter segments, and a much less conspicuous suboral costal field; and from *C. continua* in having cryptocystal dorsal areas which are lacking in the Italian species. Nevertheless, *C. continua* is most similar to *Caberoides gordoni* sp. nov., both sharing frontolateral cryptocystal areas much longer than in any of the other species.

Superfamily Hippothooidea Busk, 1859
Family Trypostegidae Gordon, Tilbrook & Winston, 2005 *in* Winston, 2005
Genus *Trypostega* Levinsen, 1909

Trypostega hasibuani sp. nov.
Pl. 7.

Figured material – Holotype: NHMUK BZ PI 6906, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after Prof. Fauzie Hasibuan (Indonesian Geological Agency - Center for Geology Survey), for his support during the fieldwork.

Diagnosis – Colony encrusting. Basal pore chambers present. Autozooids rhomboidal or irregularly polygonal. Frontal shield transversely striated and regularly perforated. Orifice cleithridiate. Ooecium prominent, rounded, evenly perforated. Kenozooids lacking.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula presumably tatiform, partially covered by a budded autozooid (Fig. 1b). Basal pore chambers visible in autozooids at the colony growing edge, small, circular, about 20 μm in diameter, evenly spaced. Autozooids arranged quincuncially, distinct, with deep interzooidal furrows, elongated (mean L/W = 1.47), rhomboidal or irregularly polygonal. Frontal shield flat or slightly depressed centrally, convex around the margins of the zooid, transversely striated, regularly perforated by 22-36 relatively large (D = 10 μm) round pores (Fig. 1c). Orifice cleithridiate, longer than broad, with a rounded anter, separated by small, proximally directed, triangular condyles from a shallow, bowl-shaped poster; slightly smaller in ovicellate zooids (Fig. 1c); oral spine bases absent. Ooecium prominent, rounded, moderately convex, broader than long, evenly perforated as frontal shield of zooids (Fig. 1c, d). Avicularia and kenozooids absent.

Measurements – ZL 349±31, 281-379 (2, 30); ZW 181±22, 167-232 (2, 30); OL 75±7, 66-87 (2, 20); OW 59±7, 50-71 (2, 20); OvL 124±12, 107-146 (2, 10); OvW 140±10, 129-163 (2, 10).

Remarks – A few fertile colonies of *Trypostega hasibuani* sp. nov. have been found encrusting the undersurfaces of platy corals from the late Burdigalian and Serravallian. Tilbrook (2006) listed the variety of morphological characters used to distinguish *Trypostega* species, which include the presence or absence of kenozooids. *Trypostega hasibuani* sp. nov. lacks kenozooids. This absence also characterises *T. rugulosa* (Reuss, 1874) from the Neogene of Europe, although Zágoršek (2010) observed irregular kenozooids in some specimens from the Miocene of the Czech Republic that he attributed to this species. However, the Kalimantan species differs from *T. rugulosa* also in having much smaller ooecia without any umbo or ridge.

Superfamily Arachnopusioidea Jullien, 1888
Family Arachnopusiidae Jullien, 1888
Genus *Poricella* Canu, 1904

***Poricella* sp.**
Pl. 8.

Figured material – NHMUK PI BZ 6907, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not observed. Autozooids distinct, with deep interzooidal furrows, irregularly arranged, hexagonal or irregularly polygonal, longer than broad (mean L/W = 1.48). Frontal shield convex, granular, with small circular marginal pores and one large, central, round foramen, sometimes occluded. Orifice slightly longer than broad, slightly narrower proximally, anter separated from the wide sinus by two small rounded condyles (Fig. 1c). An uncertain number of distal oral spine bases, probably two, still visible in some zooids (Fig. 1c). Ooecia not seen. Interzooidal avicularia numerous, usually placed on a prominent globular cystid, laterally to an autozooid, one on each side, variable in size, 200-300 μm long, elliptical with parallel sides and rounded or truncate rostrum, distally or distolaterally

directed; complete crossbar not observed (Fig. 1c, d). Vicarious avicularia common, as long as autozooids but narrower, rostrum spathulate truncated or rounded, distally or randomly directed (Fig. 1b).

Measurements – ZL 654±58, 563-731 (1, 12); ZW 442±38, 389-479 (1, 12); OL 191±8, 179-196 (1, 10); OW 147±13, 137-167 (1, 10).

Remarks – Three poorly preserved colonies of *Poricella* sp. encrust platy coral fragments from one of the Serravallian sections. In the Indo-Pacific this genus is represented at the present day by three species (Cook, 1977, p. 146): *P. celleporoides* (Busk, 1884), *P. robusta* (Hincks, 1884) and *P. spathulata* (Canu & Bassler, 1929). *Poricella* sp. is similar to *P. celleporoides* in the size of autozooids and avicularia, the shape of the orifice with two vestigial distal spines, the presence of both interzooidal and vicarious avicularia, and a single foramen. The main difference seems to be the shape of interzooidal avicularia, elliptical with parallel sides and rounded rostrum in *Poricella* sp., but spathulate in *P. celleporoides*; the absence of a complete crossbar in the Kalimantan specimen may be a preservational artefact. Furthermore, *P. celleporoides* forms large erect colonies, with anastomosing tubular expansions, which are multilaminar (Cook, 1977). *Poricella* sp. mainly differs from *P. robusta* and *P. spathulata* in always having a single foramen instead of one to three or two to twenty frontal foramina, and in the shape of interzooidal avicularia, which are asymmetrically developed in the former but spathulate and truncate in the latter species. A few species of *Poricella* have been described from the Miocene of Europe and North Africa; *P. areolata* (Reuss, 1874), *P. bugei* (El Hajjaji, 1987), *P. cookae* (Pouyet & Moissette, 1986), *P. pouyetae* (Cook, 1977) and *P. mucronata* (Smitt, 1873). Among these, the most similar to *Poricella* sp. is *P. cookae*, but this species may have one or two small foramina and a weak suboral mucron, and the interzooidal avicularia, which although similar in shape, are much squatter than those of *Poricella* sp.

Family Exechonellidae Harmer, 1957
Genus *Exechonella* Duvergier, 1924

Exechonella sp.
Pl. 9.

Figured material – NHMUK PI BZ 6908, Serravallian, TF57, 'Stadion Reef 2', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not observed. Small, numerous, marginal septular pores sometimes visible in the grooves between adjacent autozooids. Autozooids distinct, with shallow interzooidal furrows and a raised laminar border, quincuncially arranged, hexagonal or rhomboidal, slightly longer than broad (mean L/W = 1.24). Frontal shield convex, perforated by 60-80 irregularly spaced, small circular foramina, seemingly occupying the centres of polygons forming a meshwork with a narrow rim of thickened calcification sometimes still visible surrounding the foramen; up to 10 spire-like conical processes also present, associ-

ated with two or more foramina (Fig. 1b). Orifice subcircular, slightly broader than long, anter deep, rounded, proximal border concave, condyles small, triangular, proximo-medially directed (Fig. 1d). Peristome thick, low, developed proximally as a median process, peak-shaped distally (Fig. 1d). Ooecia absent. Small, oval kenozooidal structures, probably derived from septular pores, present in one or both lateral corners of some zooids, with a slightly raised rim of calcification and a small central pore (Fig. 1c); some associated with a small foramen placed laterally.

Measurements – ZL 716±56, 632-831 (1, 20); ZW 580±41, 518-640 (1, 20); OL 171±13, 151-186 (1, 20); OW 180±7, 168-194 (1, 20).

Remarks – A single colony of *Exechonella* sp. has been discovered encrusting a Serravallian pectiniid coral. The morphology of this species combines aspects of two Recent species: *E. papillata* Cook & Bock, 2004, from the Great Australian Bight, and *E. loslosensis* Tilbrook, 2006, from Pulau Loslos, Papua, Indonesia. *Exechonella* sp. is similar to *E. papillata* in having lateral kenozooids, while it is similar to *E. loslosensis* in having frontal projections. Autozooidal size in the Kalimantan specimen falls between the two Recent species: 0.63-0.83 × 0.52-0.64 mm in *Exechonella* sp. vs 0.45-0.59 × 0.43-0.50 and 1.40-1.70 × 0.90-1.30 mm in *E. papillata* and *E. loslosensis*, respectively.

Genus *Oviexechonella* gen. nov.

Type species – *Oviexechonella digeronimoi* sp. nov., Serravallian, East Kalimantan, Indonesia.

Etymology – *Ovi-* from the Latin ovum, in reference to the presence of ooecia in an *Exechonella*-like species.

Diagnosis – Colony encrusting, unilaminar. Autozooids with frontal shield perforated by numerous foramina surrounded by a raised rim of calcification. Marginal pores present, though often inconspicuous and obscured by the prominent and swollen frontal shield, at the boundaries between adjacent zooids. Orifice semicircular, obscured by a tall, imperforate, tubular peristome. Ooecium hyperstomial, globular, cap-like, resting on the peristome. Avicularia absent.

Remarks – This new genus is introduced for a new *Exechonella*-like species characterised by the presence of hyperstomial ooecia. The genus *Exechonella* was founded by Duvergier (1924), with *Cyclicopora*? *grandis* Duvergier, 1921 (p. 34, pl. 3, figs. 2-3) from the Aquitanian (Early Miocene) of the Gironde, France, as the type species. Ooecia have not been directly observed before in any species of the genus and it has been generally supposed that *Exechonella* is an internal brooder. Fransen (1986, p. 88, fig. 29f, g) illustrated the inner structure of the zooid and embryos in specimens of *E. antillea* (Osburn, 1927) from the Caribbean, while Cook (1985, p. 130) described dimorphic zooids, with a distinctly larger secondary calcified orifice and operculum than surrounding zooids of the same astogenetic generation, in two specimens of *E. antillea* from Ghana. However, Canu & Bassler (1929, p. 123) described "small ovicells, punctured by

small pores and opening into the peristome above the aperture" in their new species, *E. discoidea*, from the Philippines but these were not illustrated. Examination of the type material of this species is required to confirm the presence of ooecia and to attribute it unequivocally to this new genus.

All of the other genera assigned at present to the family Exechonellidae – *Anexechona* Osburn, 1950, *Stephanopora* Kirkpatrick, 1888, and *Xynexecha* Gordon & d'Hondt, 1997 – lack ooecia. Nevertheless, Harmer (1957, p. 651), in the original definition of the family Exechonellidae, introduced for *Exechonella* alone, remarked only about the umbunoloid nature of the frontal shield, not mentioning the method of reproduction. In the description of the genus, however, he reported "small ovicells, on the distal sides of the peristomes" (Harmer, 1957, p. 652), based on *E. discoidea*. It is most likely that Exechonellidae were not internal brooders early in their evolutionary history, and therefore that external calcified ooecia should be expected to occur in some of the early representatives, providing a character for generic differentiation within the family in addition to those suggested by Tilbrook (2006, p. 116). This author distinguished two groups within a number of *Exechonella* species - the first characterised by a long peristome and lack of condyles in the orifice, the second with a small or no peristome, discernible condyles in the orifice and adventitious avicularia - suggesting a possible splitting of *Exechonella* along these lines after further thorough examination of type material of all species involved. Cook & Bock (2004) defined four groups of species among their South Australian material.

Oviexechonella digeronimoi **sp. nov.**

Pl. 10.

Figured material – Holotype: NHMUK PI BZ 6909, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Etymology – Named after Prof. Italo Di Geronimo, palaeontologist at the University of Catania, for his research on Pleistocene and Recent invertebrates.

Diagnosis – Colony encrusting. Autozooids flask-shaped. Frontal shield perforated. Orifice semicircular obscured by an imperforate, tubular peristome. Ooecia imperforate, cap-like. Avicularia absent.

Description – Colony encrusting, multiserial, unilaminar. Ancestrular morphology unknown, preserved only in outline, seemingly much smaller than later autozooids, about 230 μm long by 190 μm wide (Fig. 1a, see arrow). Autozooids distinct with deep interzooidal furrows, quincuncially arranged, flask-shaped, longer than broad (mean L/W = 1.53). Frontal shield deeply convex, depending on the size of the zooid perforated by approximately 25-40 almost regularly spaced, circular pores, mean diameter 35 μm, each surrounded by a slightly raised conical rim of calcification (Fig. 1c); inconspicuous marginal pores sometimes visible along zooidal margins. Orifice semicircular, slightly broader than long, with a straight proximal margin, obscured by an imperforate, tubular, on average 200 μm long peristome, outlining a subcircular aperture when undamaged. Ooecia common, hyperstomial, imperforate, broader than long, cap-like, resting on the distal side of the peristome (Fig. 1d). Avicularia absent.

Measurements – ZL 546±20, 527-572 (1, 10); ZW 358±26, 324-390 (1, 10); OL 83±8, 71-91 (1, 5); OW 98±13, 82-110 (1, 5); OvL 122±21, 94-144 (1, 4); OvW 172±18, 153-190 (1, 4).

Remarks – A few small colonies of *Oviexechonella digeronimoi* sp. nov. have been found encrusting a platy coral from one of the Serravallian section. The colonies are fan-shaped and precociously fertile, the first ovicellate zooids occurring a couple of generations after the ancestrula. *Oviexechonella digeronimoi* sp. nov. is similar in morphology to the Recent Australian species *Exechonella ampullacea* Hayward & Ryland, 1995, *E. tuberculata* (MacGillivray, 1883) and *E.* sp. cf. *discoidea* Canu & Bassler, 1929, illustrated by Cook & Bock (2004), and *E. anuhaensis* Tilbrook, 2006, from the Solomon Islands, differing from all of these species in having peristomial ooecia and much smaller zooids.

Superfamily Adeonoidea Busk, 1884
Family Adeonidae Busk, 1884
Genus *Adeonellopsis* Levinsen, 1909

***Adeonellopsis* aff. *obliqua* MacGillivray, 1895**
Pl. 11, fig. 1a-c.

aff. *Adeonellopsis obliqua* MacGillivray, 1895, p. 68, pl. 9, figs. 7-11.

Figured material – NHMUK PI BZ 6910, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony rigidly erect, adeoniform. Branches strap-like, presumably arising from an encrusting base (not observed), bilaminate, with five longitudinal rows of alternating autozooids, bifurcating at an angle of about 100° (Fig. 1a). Autozooids distinct with shallow interzooidal furrows, apparently monomorphic, rounded rhombic in outline, slightly broader medio-distally, elongate (mean L/W = 1.76). Frontal shield faintly granular, with a strongly inflated, heavily calcified rounded ridge enclosing orifice, suboral avicularium, and spiramen in a deep, well-like depression (Fig. 1b). Areolar pores small, circular, simple, without interareolar buttresses, distributed in one complete row around periphery of zooid. Spiramen usually obliterated by sediment infilling, in some zooids seemingly a depressed oval disc placed at middle length of the frontal surface, perforated by a circular pore distally placed. Orifice circular to semicircular, encircled by peristome formed by direct upward growth of the thickened calcified peripheral ridge and indented proximally by the suboral avicularium (Fig. 1c). A small rounded suboral tubercle present on the frontal shield of some autozooids, placed lateral to the frontal avicularium. Gonozooid not recognized. Suboral avicularium present on each autozooid, extending obliquely from a point distal to the spiramen to proximolateral corner of the orifice; rostrum subtriangular, slightly curved, its tip pointed and indenting the orifice; premandibular portion trifoliate (Fig. 1c), separated from mandibular portion by a pair of blunt pivotal condyles. Additional frontal adventitious, interzooidal and vicarious avicularia absent.

Measurements – ZL 374±26, 330-430 (2, 20); ZW 212±15, 178-232 (2, 20); OL 66±5, 59-71 (2, 10); OW 81±4, 76-86 (2, 10); AL 183±16, 161-212 (2, 20).

Remarks – Branch fragments of *Adeonellopsis* aff. *obliqua* are reasonably common in the late Burdigalian sediments. Their preservation is generally poor, compromising observation of the spiramen and the avicularium palate. However, the trifoliate palate, a character diagnostic of the Cenozoic Australian species *Adeonellopsis obliqua*, is still preserved at least in one of the suboral avicularia (Fig. 1c). Nevertheless, the Kalimantan specimens differ from the Australian species in having smaller zooids and in lacking small frontal avicularia with proximally directed rostra.

***Adeonellopsis* sp. 1**
Pl. 11, fig. 2a, b.

Figured material – NHMUK PI BZ 6911, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony rigidly erect, adeoniform. Branches strap-like, presumably arising from an encrusting base (not observed), bilaminate, with up to four longitudinal rows of alternating autozooids (Fig. 2a). Autozooids distinct with shallow interzooidal furrows, apparently monomorphic, oval in outline, elongate (mean L/W = 2.35). Frontal shield smooth, flat, in some zooids raised distally (Fig. 2b). Areolar pores very small, circular to oval, forming a complete row around periphery of zooid, each set within an areola flanked by low buttresses. Spiramen circular, relatively large (mean D = 40 μm), encircled by a slightly elevated rim and placed at about mid-length of the frontal surface. Orifice circular to semicircular, encircled distally by the peristome formed by direct upward growth of the thickened calcified margin and proximally delimited by the suboral avicularium. Gonozooid not recognized. Suboral avicularium present on each autozooid, distolaterally directed, towards the outer side of the branch; rostrum subtriangular with pointed tip. Additional frontal adventitious, interzooidal and vicarious avicularia not seen.

Measurements – ZL 432±31, 381-486 (2, 24); ZW 184±12, 162-199 (2, 24); OL 81±2, 78-83 (2, 10); OW 93±5, 87-99 (2, 10); AL 111±12, 95-123 (2, 10).

Remarks – *Adeonellopsis* sp. 1 is abundant in the Burdigalian-Langhian of East Kalimantan. It differs from *A.* aff. *obliqua* in having much more slender branches, more elongate zooids, and smaller suboral avicularia.

***Adeonellopsis* sp. 2**
Pl. 11, fig. 3a-c.

Figured material – NHMUK PI BZ 6912, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony rigidly erect, adeoniform. Branches strap-like, presumably arising from an encrusting base (not observed), bifurcating at an angle of 90-110°, bilaminate, tapering proximally with three to six longitudinal rows of alternating autozooids, with the zooids in the central two rows aligned parallel to the branch axis and the outer zooids directing outwards at an angle of *c.* 25° (Fig. 3a). Autozooids distinct

with shallow interzooidal furrows, apparently monomorphic, rhomboidal to rounded polygonal in outline, elongate (mean L/W = 1.97). Frontal shield finely granular, with a heavily calcified raised ridge surrounding the orifice, suboral avicularium and spiramen (Fig. 3b). One or two small rounded suboral tubercles present at sides of orifice in some autozooids, probably formed as ontogenetic calcification progresses. Areolar pores small and circular, forming a complete row around periphery of zooid. Spiramen circular, relatively large (mean D = 40 μm), placed in a depression of the frontal wall, at about one-third from the proximal end of the zooid. Orifice circular to semicircular, proximolaterally indented by the suboral avicularium. A single poorly preserved ?maternal zooid, with a swollen distal margin and two rows of areolar pores (Fig. 3c). Suboral avicularium present on each autozooid, distolaterally directed towards the outer side of the branch; rostrum subtriangular with pointed tip. Additional frontal adventitious, interzooidal and vicarious avicularia not seen.

Measurements – ZL 403±25, 373-458 (2, 30); ZW 205±15, 182-221 (2, 30); OL 78±7, 69-88 (2, 20); OW 93±7, 84-101 (2, 20); AL 163±15, 137-182 (2, 10).

Remarks – *Adeonellopsis* sp. 2 is abundant in the Serravallian sediments. It differs from the Burdigalian-Langhian *A.* sp. 1 in having colonies with much wider and flatter branches, zooids of a similar size but with different length/width proportions, slightly larger areolar pores, longer suboral avicularia, and a more raised and tuberculate frontal surface.

Genus *Reptadeonella* Busk, 1884

Reptadeonella curvabilis sp. nov.

Pl. 12.

Figured material – Holotype: NHMUK PI BZ 6913, late Burdigalian, TF126, '3D Reef', Bontang; Paratype: NHMUK PI BZ 6914, same details as holotype.

Etymology – Referring to its avicularia that may be bent.

Diagnosis – Colony encrusting. Autozooids irregularly polygonal. Frontal shield with a single series of marginal pores, and a single, central, round spiramen. Orifice semicircular. Peristome short. Adventitious avicularia suboral, dimorphic, either elongate triangular or sickle-shaped.

Description – Colony encrusting, multiserial, unilaminar, often forming extensive sheets. Ancestrula not observed. Autozooids distinct with shallow interzooidal furrows, arranged quincuncially, irregularly polygonal, longer than broad (mean L/W = 1.73). Frontal shield flat, finely granular with a single series of large, oval to circular, closely spaced marginal pores and a single round spiramen situated in a depression at centre of zooid. Orifice circular, surmounting a short peristome. Gonozooid not seen. Adventitious avicularia dimorphic, either suboral, long (L = 150-200 μm) and thin, with triangular rostrum (Fig. 1c, d), distolaterally directed, or large (mean L = 300 μm),

gently curving and sickle-shaped (Fig. 1b), originating distolaterally of spiramen, the rostrum replacing one side of the peristome and affecting the shape of the orifice, expanded proximally, narrowing distally, with smooth lateral edges, outer edge higher than inner, no crossbar, distal tip channelled. Accessory pores seen around avicularian cystid.

Measurements – ZL 553±67, 488-661 (5, 50); ZW 319±25, 269-338 (5, 50); OL 125±10, 114-137 (5, 50); OW 102±7, 94-111 (5, 50).

Remarks – *Reptadeonella curvabilis* sp. nov. is one of the most abundant species in the late Burdigalian reef, forming extensive sheet-like colonies, which typically cover more substrate space than other species. Tilbrook (2006) noted the presence of several species of *Reptadeonella* (e.g., *R. fissa* (Hincks, 1880), *R. falciformis* Tilbrook, 2006, *R. joloensis* Bassler, 1936, *R. novissima* Tilbrook, 2006, *R. phelleaphila* Tilbrook, 2006, and *R. sicilis* Tilbrook, 2006), in the Recent Indo-West Pacific with sickle-shaped avicularia, differing from one another in the size, position and orientation of these large avicularia. *Reptadeonella curvabilis* sp. nov. is similar to *R. fissa* in the size of autozooids and in having only one set of pores plus accessory pores surrounding the avicularian cystid, while it differs in having smaller sickle-shaped avicularia affecting the shape of the orifice itself. This is also the case in *R. joloensis* and *R. phelleaphila,* the former differing from *R. curvabilis* sp. nov. in having a more tuberculate frontal surface, with a series of marginal pores and numerous accessory pores randomly positioned across the whole frontal surface, while *R. phelleaphila* differs in having far larger sickle-shaped avicularia originating laterally to the spiramen instead of distally. Long, thin suboral avicularia have been previously described in *R. falciformis* Tilbrook, 2006, and *R. novissima* Tilbrook, Hayward & Gordon, 2001, respectively proximolaterally and distolaterally directed. However, in *R. novissima* they are not accompanied by sickle-shaped avicularia. Unfortunately, the orifice is always filled with sediment, precluding observation of a possible denticulate proximal border and/or articulatory condyles, additional characters useful to distinguish species.

***Reptadeonella toddi* sp. nov.**

Pl. 13.

Figured material – Holotype: NHMUK PI BZ 6915, Serravallian, TF51, 'Stadion Reef 1', Samarinda; Paratypes: NHMUK PI BZ 6916, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang; NHMUK PI BZ 6917, Serravallian, TF57, 'Stadion Reef 2', Samarinda.

Etymology – Named after Jon Todd (Department of Earth Sciences, NHMUK) who helped collecting samples.

Diagnosis – Colony encrusting, developing from a twin ancestrular complex. Autozooids hexagonal. Frontal shield with a single or double series of marginal pores and a single, central, rounded spiramen. Orifice subcircular with raised peristome. Gonozooids identical to autozooids but swollen distally. Adventitious avicularia suboral, pear-shaped.

Description – Colony encrusting, multiserial, unilaminar, often forming extensive sheets. Twin ancestrular complex, with zooids set at angle of 180° to each other, smaller than budded autozooids, elongated, about 140 μm long by 60 μm broad (Fig. 1d). Autozooids distinct with deep interzooidal furrows, arranged quincuncially, hexagonal, longer than broad (mean L/W = 1.51). Frontal shield convex, finely granular, with a single or sometimes double series of small, circular, closely spaced, marginal pores and a single round spiramen at centre of zooid (Fig. 1b). Orifice subcircular, surmounting a short, raised peristome. Gonozooids identical to autozooids but slightly swollen distally, with up to three series of marginal pores, and orifice placed more proximally (Fig. 1e, f, see arrows). Adventitious avicularia suboral, originating distally of spiramen, pear-shaped, broader proximally, narrow distally with a rounded triangular rostrum, distolaterally directed (Fig. 1c). Accessory pores widely spaced, delimiting a subtriangular or rhomboidal avicularian cystid.

Measurements – ZL 745±55, 636-839 (5, 50); ZW 495±42, 421-559 (5, 50); OL 108±2, 106-110 (5, 30); OW 128±11, 118-140 (5, 30); AL 218±20, 189-239 (5, 30); AW 136±12, 119-146 (5, 30).

Remarks – In terms of substrate occupancy, *Reptadeonella toddi* sp. nov., along with two species of *Steginoporella*, account for the main abundance of bryozoans in the Burdigalian-Langhian and especially in the Serravallian sections. These species have a tendency to monopolize the substrate, forming very extensive sheet-like colonies on the undersides of platy corals. *Reptadeonella toddi* sp. nov. differs from *R. curvabilis* sp. nov. in having rather larger zooids, smaller marginal pores, a much more convex frontal shield, and only one type of adventitious avicularia. The pear-shaped suboral avicularium, expanded proximally, with a narrow subtriangular rostrum that is distally rounded, characterizes this new species and allows it to be distinguished from previously described fossil and Recent species of *Reptadeonella*.

Superfamily Lepralielloidea Vigneaux, 1949
Family Lepraliellidae Vigneaux, 1949
Genus *Celleporaria* Lamouroux, 1821

***Celleporaria* sp.**
Pl. 14.

Figured material – NHMUK PI BZ 6918, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, multilaminar. Autozooids distinct with deep interzooidal furrows, irregularly arranged, erect, deep-bodied, hexagonal to irregularly polygonal, slightly longer than wide (mean L/W = 1.15) (Fig. 1b, d). Frontal shield convex, smooth, imperforate; small, circular areolar pores sometimes visible around zooidal margins. Orifice transversely D-shaped, with straight or slightly concave proximal margin, wider than long (Fig. 1d). Two distolateral spine bases, widely spaced (Fig. 1d). Suboral avicularium submedial, varying in size, the rostrum raised above frontal shield, triangular with rounded distal tip, facing frontally, directed laterally, crossbar complete (Fig. 1c, d). Vicarious avicularia and ooecia not seen.

Measurements – ZL 390±32, 325-431 (2, 30); ZW 339±26, 306-375 (2, 30); OL 107±13, 92-120 (2, 10); OW 144±10, 133-155 (2, 10); AL 156±33, 95-192 (2, 15).

Remarks – *Celleporaria* sp. forms mound-like colonies on small bioclasts. A few colonies have been found in the Serravallian 'Batu Putih 1' section. Sediment obscures the primary orifice, preventing the observation of any teeth-like processes or condyles. This species shares some features, such as the transversely D-shaped orifice outline, the presence of two oral spine bases, and the suboral avicularium having a raised, triangular rostrum, with the Recent Australian *C. bispinata* (Busk, 1854).

Family Romancheinidae Jullien, 1888
Genus *Hippomenella* Canu & Bassler, 1917

?*Hippomenella devatasae* sp. nov.
Pl. 15.

Figured material – Holotype: NHMUK PI BZ 6919, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after the south-east Asian mythological goddess Devatas.

Diagnosis – Colony encrusting. Autozooids large, subhexagonal. Frontal shield rugose to nodular. Lateral areolar pores not directly observable owing to sediment infill. Orifice with blunt condyles, arched anter and bowed proximal margin. Prominent suboral mucro. Eight oral spine bases, four in ovicellate zooids. Ooecium subpentagonal, with two proximolateral fenestrae. Three adventitious, small bell-shaped avicularia on each autozooid.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula, early astogeny and pore chamber windows not observed. Autozooids distinct with deep interzooidal furrows, irregularly arranged, relatively large, subhexagonal, slightly longer than wide (mean L/W = 1.22), widest at about mid-length (Fig. 1a). Frontal shield flat or slightly convex, rugose to nodular, central area imperforate, ridges around zooidal margin radially aligned, small areolar pores sometimes visible between them (Fig. 1a). Orifice longer than wide with blunt condyles, separating an arched anter from a smaller poster with a bowed proximal margin (Fig. 1b). Peristome proximolaterally raised, forming a prominent median suboral mucro. Eight oral spine bases along distolateral orifice margin (Fig. 1b), mean diameter 25 μm; four in ovicellate zooids (Fig. 1c). Ooecium subpentagonal, wider than long, smooth ectooecium incompletely calcified,, forming two large proximolateral fenestrae exposing the thickly calcified and densely pitted endooecium (Fig. 1c). Three adventitious, monomorphic avicularia on each autozooid, small bell-shaped, crossbar complete, rostrum rounded, placed on small, globular, raised, smooth cystids (Fig. 1a, d); two avicularia placed proximolaterally to orifice at zooid margin, proximolaterally directed; one avicularium placed at mid-width of the proximal margin of the zooid, proximally directed.

Measurements – ZL 694±26, 647-720 (1, 10); ZW 568±47, 526-631 (1, 10); OL 145±6, 139-151 (1, 5); OW 117±1, 116-118 (1, 5); OvL 178±14, 162-188 (1, 3); OvW 255±3, 252-258 (1, 3); AL 82±9, 72-94 (1, 15).

Remarks – A few colonies of ?*Hippomenella devatasae* sp. nov. have been found on the underside of late Burdigalian platy corals. This species is tentatively assigned to *Hippomenella* based on the appearance of the frontal shield, nodular and rugose, with a wide imperforate central area, and radially aligned buttresses separating lateral areolar pores. In contrast, the ooecium, with two proximolateral fenestrae revealing a densely pitted endooecium, is similar to the type species of *Hippopleurifera*, *H. biauriculata* (Reuss, 1847). The first description of *Hippomenella* by Canu & Bassler (1917) is based on the type species of *Hippomenella*, *H. mucronelliformis* (Waters, 1899), for the structure of the frontal shield, but on fossil species from the USA for the structure of the ooecium because ooecia of *H. mucronelliformis* were unknown at that time (Tilbrook, 2006). The poor definition of the genus led to the inclusion in it of species characterised by different types of ooecia. Tilbrook (2006) distinguished two groups of *Hippomenella*, the *mucronelliformis*-group and the *lateralis*-group, the former having a uniformly perforate ooecium, the latter with a bifenestrate ooecium. Berning (2013) amended the generic diagnosis, including in the genus only species characterised by a hyperstomial ooecium with uncalcified ectooecium and a finely pitted endooecial surface in parts but devoid of any other structures. Based on this conservative definition, the Kalimantan species should be included in *Hippopleurifera*. However, *Hippopleurifera* differs in having almost the entire frontal shield perforated by areolar pores. The combination in the Kalimantan species of these two characters – a bifenestrate ooecium typical of *Hippopleurifera* and an imperforate frontal shield characteristic of *Hippomenella* – may constitute an argument for synonymising these two genera. However, a more complete revision is needed to support this synonymy, which is beyond the scope of the current paper. The small bell-shaped, adventitious avicularia are characteristic of this fossil species, and have not been observed in any other species of *Hippomenella* or *Hippopleurifera*, Recent or fossil. *Hippomenella parviporosa* Canu & Bassler, 1935, has a very similar frontal shield, with small areolar pores separated by radial costules, and 2-3 small triangular avicularia, but lacks oral spines and a raised peristome, and the ooecium is unknown in this species. The genus *Hippomenella* is here placed in the family Romancheinidae following Berning (2013).

***?Hippomenella uniserialis* sp. nov.**

Pl. 16, fig. 1a-e.

Figured material – Holotype: NHMUK PI BZ 6920, late Burdigalian, TF126, '3D Reef', Bontang. Paratype: NHMUK PI BZ 6921, same details as holotype.

Etymology – For its uniserial colony-form.

Diagnosis – Colony encrusting, uniserial. Autozooids large, oval. Frontal shield smooth, imperforate, sometimes with ridges around zooidal margins. Orifice with pointed condyles, arched anter and rounded poster. Nine to ten oral spine bases, six in ovicellate zooids. Ooecium globular with two lateral fenestrae. Avicularia absent.

Description – Colony encrusting, uniserial. Ancestrula and early astogeny not observed. Pore chamber windows absent. Uniserial branches bifurcating at almost 90° through the formation of left and right distolateral buds (Fig. 1a). Autozooids large, oval, longer than wide (mean L/W = 1.45). Frontal shield convex, smooth, with up to three lateral and distal rows of small circular pores (mean D = 20 μm) and imperforate central area, sometimes with ridges aligned radially around zooidal margin (Fig. 1d, e). Orifice longer than wide with pointed, downwardly directed condyles separating an arched anter from a smaller poster with a rounded proximal margin (Fig. 1b). Peristome slightly raised proximally. Nine to ten oral spine bases along distolateral orifice margin, mean diameter 30 μm; six in ovicellate zooids (Fig. 1c-e). Ooecium globular, wider than long, smooth, with two lateral fenestrae (Fig. 1c). Avicularia absent.

Measurements – ZL 668±41, 612-708 (3, 15); ZW 462±24, 436-482 (3, 15); OL 173±11, 159-184 (3, 10); OW 150±13, 135-167 (3, 10); OvL 178±15, 168-189 (1, 2); OvW 226±7, 220-231 (1, 2).

Remarks – ?*Hippomenella uniserialis* sp. nov. is common and abundant on the undersides of late Burdigalian platy corals where it is often overgrown by encrusting foraminifera. As in ?*Hippomenella devatasae* sp. nov., the frontal shield of this uniserial species shows a wide imperforate central area outside of which are radial ridges, and the ooecia, although poorly preserved, appear to bear a pair of lateral fenestrae. Based on the above mentioned characters (see also 'Remarks' for ?*Hippomenella devatasae* sp. nov.), it has been tentatively assigned to *Hippomenella.* ?*Hippomenella uniserialis* sp. nov. differs from ?*H. devatasae* sp. nov. in developing uniserial colonies, in the number of oral spine bases in both ovicellate (6 vs 4) and non-ovicellate zooids (9 or 10 vs 8), and in the lack of avicularia. The main diagnostic character for this species is the uniserial colony-form, which has not been described previously for any species of *Hippomenella* or *Hippopleurifera*, Recent or fossil.

Family Umbonulidae Canu, 1904
Genus *Umbonula* Hincks, 1880

***?Umbonula* sp.**
Pl. 16, fig. 2a-c.

Figured material – NHMUK PI BZ 6922, Langhian, TF56, 'Badak South', Samarinda.

Description – Colony encrusting, uniserial, new branches oriented at about 30° to the parent branch and formed by distolateral budding (Fig. 2a). Ancestrula and early astogeny not observed. Autozooids large, rectangular, longer than wide (mean L/W = 1.28). Frontal shield convex, smooth, with prominent radial ribs extending from marginal areolar pores and as far as the mid-line of the frontal wall (Fig. 2b). Marginal areolar pores large, circular or oval, 70-110 μm long (Fig. 2c). Orifice oval, longer than wide. Peristome slightly raised. Ooecia and avicularia not seen.

Measurements – ZL 852±49, 781-900 (1, 5); ZW 667±14, 651-683 (1, 5); OL 259±15, 242-270 (1, 3); OW 185±18, 165-193 (1, 3).

Remarks – A single colony, with only five zooids, of this species has been discovered on the underside of a Langhian platy coral. It is questionably identified as *Umbonula*, despite the lack of oral and suboral avicularia characteristic of this genus, because the strongly ribbed frontal shield resembles that of *U. macrocheila* (Reuss, 1847) as figured by Schmid (1989, pl. 8, fig. 1) and Zágoršek (2010, pl. 92, fig. 3).

Family Tessaradomidae Jullien, 1903
Genus *Sendinopora* gen. nov.

Type species – *Sendinopora prima* sp. nov., Serravallian, East Kalimantan, Indonesia.

Etymology – Named after Consuelo Sendino, fossil bryozoan curator at the NHMUK.

Diagnosis – Colony erect, rigid, dichotomously branching. Branches subcylindrical, quadriserial. Autozooids distinct, arranged in alternating longitudinal rows. Frontal shield imperforate apart from one or more rows of areolar pores close to zooidal margins; spiramen mediodistal. Peristome raised, tubular, including a small proximal avicularium. Orifice semicircular. Oral spines absent. Ooecia not observed.

Remarks – This new genus is introduced for a Serravallian species characterised by quadriserial branches, peristomial avicularia and a marginally areolate frontal shield. It has been placed within the family Tessaradomidae because of its imperforate frontal shield apart from marginal areolar pores. However, *Tessaradoma* Norman, 1869, has prominent, imperforate ooecia and differs from the new genus also in lacking peristomial avicularia. Within the same family, Recent *Smithsonius dorothea* (Winston & Beaulieu, 1999) shows a similar striated appearance of colony walls, but differs in having biserial rather than quadriserial branches and a peristomial sinus rather than an enclosed spiramen. Within the family Porinidae, *Tremotoichos* Canu & Bassler, 1917, shows a similar suboral avicularium but its spiramen is more proximally placed. It also differs in having lateral branching and peristomes opening only on the frontal side, a feature that characterises other genera in the family such as *Haswelliporina* Gordon & d'Hondt, 1997, and *Semihaswellia* Canu & Bassler, 1917. Furthermore, the frontal shield of porinids is pseudoporous, as it is in Margarettidae. *Margaretta* Gray, 1843, has a similar colony form and spiramen, but it differs, in addition to frontal shield porosity, in lacking avicularia. Within the family Siphonicytaridae, *Siphonicytara* Busk, 1884, differs in having the spiramen placed in a sharply marked area, outlined by distinct septal lines, an orifice which occupies a large part of the frontal surface and usually very large avicularia. As in *Sendinopora* it lacks ooecia. Adeonellidae and Adeonidae have marginal areolar pores, a roughly semicircular orifice, suboral avicularia and lack ooecia. Genera included in these two families, however, are bilaminar foliaceous (e.g., *Adeonella, Adeonellopsis, Adeona*) or encrusting (e.g., *Reptadeonella*).

***Sendinopora prima* sp. nov.**
Pl. 17.

Figured material – Holotype: NHMUK PI BZ 6998, Serravallian, TF76, 'Batu Putih 1', Samarinda. Paratypes: NHMUK PI BZ 6999, BZ 7000, same details as holotype.

Etymology – Referring to the first species of this new genus.

Diagnosis – Colony erect. Branches quadriserial. Autozooids rhomboidal. Frontal shield ridged, imperforate except for a few, marginal areolar pores. Ascopore mediodistally placed. Peristome tubular with half-moon shaped avicularium. Secondary orifice semicircular. Ooecia absent.

Description – Colony erect, rigid, dichotomously branching at an angle of 30°; branches subcylindrical, quadriserial (Fig. 1a, d). Autozooids distinct with interzooidal shallow furrows, arranged in alternating longitudinal rows, rhomboidal, longer than wide (mean L/W = 1.98), tapering proximally, raised distally (Fig. 1b, c, e). Frontal shield flat or slightly convex, faintly granular, ridged, imperforate apart from one to three rows of small, round, areolar pores along zooidal margins; ascopore round, placed mediodistally and surrounded by a slightly raised rim (Fig. 1f). Peristome prominent, tubular, rising perpendicularly to the frontal plane (Fig. 1c), including on its proximal edge a small, half-moon shaped avicularium, transversely oriented, about 70 μm long (Fig. 1f); pivotal bar and condyles not observed. Secondary orifice semicircular, wider than long (Fig. 1f). Ooecia absent.

Measurements – ZL 947±22, 907-977 (10, 100); ZW 478±21, 445-504 (10, 100); OL 123±3, 119-125 (10, 50); OW 163±6, 157-169 (10, 50).

Remarks – Branch fragments of *Sendinopora prima* sp. nov. are very abundant (*c.* 3500 specimens) in Serravallian silty sediments collected at 'Batu Putih 1'. This species is characterised by its frontal shield with narrow ridges and sulci and half-moon shaped peristomial avicularium.

Superfamily Smittinoidea Levinsen, 1909
Family Smittinidae Levinsen, 1909
Genus *Parasmittina* Osburn, 1952

***Parasmittina* sp.**
Pl. 18.

Figured material – NHMUK PI BZ 6923, Serravallian, TF57, 'Stadion Reef 2', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, arranged quincuncially, rectangular to rhomboidal, slightly broader than long (mean L/W = 0.89) (Fig. 1a, c). Frontal shield slightly convex, coarsely granular, with a single series of large, irregularly shaped, marginal areolar pores. Orifice rounded, longer than wide, median lyrula relatively narrow, occupying approximately one-fifth of proximal border, anvil-shaped, with sharply pointed corners and convex distal edge (Fig. 1b); character of the distal border and condyles not discernible. Two distal oral spine bases (Fig. 1a, c). Peristome most developed laterally; secondary orifice rounded subtriangular,

the distal edge almost straight. Ooecia not observed. Adventitious avicularia variable in size, 100 to 160 μm long, lateral-suboral, single or paired, with oval or slightly spatulate rostrum, proximally directed (Fig. 1d). No giant avicularia seen.

Measurements – ZL 449±20, 424-470 (2, 20); ZW 504±17, 491-526 (2, 20); OL 139±10, 127-152 (2, 20); OW 108±11, 88-124 (2, 20).

Remarks – A few, poorly preserved colonies of *Parasmittina* sp. have been discovered on the undersides of late Burdigalian and Serravallian platy corals. A number of features have been generally used to distinguish species of *Parasmittina*, in particular: size and shape of the median lyrula and lateral condyles; denticulation of the anter; number of distal oral spines; size, shape and orientation of adventitious and giant avicularia. Unfortunately, the Kalimantan specimens lack ooecia and giant avicularia and, in addition, their poor preservation does not allow observation of the distal edge of the primary orifice or the condyles. Some of the characters that are still preserved, such as the two distal oral spines and the shape of adventitious avicularia, are found in numerous species belonging to this speciose genus.

Genus *Pleurocodonellina* Soule & Soule, 1973

?Pleurocodonellina sp.

Pl. 19.

Figured material – NHMUK PI BZ 6924, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows containing salient lateral walls, arranged more or less in longitudinal rows, rectangular or irregularly polygonal, slightly longer than broad (mean L/W = 1.36) (Fig. 1b, c). Frontal shield convex, coarsely nodular, bordered by a single row of large and numerous areolar pores. Primary orifice always occluded by sediment. Secondary orifice longer than wide, with a horseshoe-shaped anter and a narrow proximomedial sinus (Fig. 1b-d). Oral spines lacking. Peristome most developed laterally. Ooecium immersed, large, globular, broader than long, covered by secondary calcification having the same appearance as the frontal shield, perforated proximally (Fig. 1c, d). Adventitious avicularia dimorphic, proximolateral, suboral, unpaired, complete crossbar; most commonly small, about 120 μm long by 80 μm wide, oval, distally directed; rarely large, about 210 μm long by 140 μm wide, triangular with rounded tip, distolaterally directed (Fig. 1b).

Measurements – ZL 868±20, 836-886 (1, 20); ZW 640±25, 598-661 (1, 20); OL 235±16, 212-256 (1, 20); OW 190±18, 170-203 (1, 20); OvL 319±13, 310-328 (1, 5); OvW 475±30, 443-503 (1, 5).

Remarks – A single fairly large colony of ?*Pleurocodonellina* sp. has been discovered on a late Burdigalian platy coral. Species of *Pleurocodonellina* are distinguished by the shape of the orificial sinus and lateral condyles, the shape and orientation of the

avicularia, and by the shape and the number of pores in the exposed ectooecium. The Kalimantan specimen is only tentatively referred to *Pleurocodonellina* because, unfortunately, the shape of the sinus, as well as the characters of condyles, are obliterated by sediment infilling. However, the general appearance of the frontal shield, as well as the avicularia arising from the lateral areolar pores, fit the definition of the genus. Whereas at least part of the porous ectooecium is exposed in other *Pleurocodonellina* species, secondary calcification of the distal zooid entirely covers the primary ooecium structure in the Kalimantan species.

Genus *Smittina* Norman, 1903

Smittina sp.

Pl. 20.

Figured material – NHMUK PI BZ 6925, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula not preserved. First generation of autozooids smaller in size (320-370 μm long by 220-250 μm wide) than later autozooids (Fig. 1a). Autozooids distinct with interzooidal shallow furrows, quincuncially arranged, rounded rectangular to irregularly polygonal, longer than broad (mean L/W = 1.34) (Fig. 1b, c). Frontal shield convex, evenly perforated by large circular pseudopores seemingly obliterated by sediment, with a distinct single series of larger, irregularly shaped, marginal areolar pores (Fig. 1b, c). Secondary orifice squared, slightly broader than long, lyrula wide, occupying approximately half of proximal border, anvil-shaped, with rounded corners and convex distal edge (Fig. 1c); condyles not seen. Three or two distal oral spine bases, widely spaced (Fig. 1c). Peristome moderately raised all around the orifice, open proximomedially with an avicularium obscuring base of lyrula. Ooecia globular, broader than long, immersed, roof broken, ?porous (Fig. 1b, c). Suboral avicularium small, circular, raised rostrum directed proximofrontally, palate steeply sloping inwards, crossbar complete (Fig. 1d).

Measurements – ZL 504±43, 420-571 (1, 13); ZW 377±32, 330-431 (1, 13); OL 134±10, 117-140 (1, 10); OW 143±11, 127-158 (1, 10); OvL 217±29, 196-257 (1, 4); OvW 257±12, 240-266 (1, 4); AL 60±5, 57-65 (1, 5).

Remarks – A single small colony of *Smittina* sp. has been discovered on a late Burdigalian platy coral. Two species of this genus have been previously described from the Recent of Indonesia, *S. abyssicola* (Harmer, 1957) and ?*S. exclusa* (Harmer, 1957). The Kalimantan specimen differs from the former species in having distinct marginal areolar pores and distal oral spines, while it differs from the latter in being encrusting instead of erect and in the lack of frontal avicularia.

Genus *Smittoidea* Osburn, 1952

Smittoidea cf. *pacifica* Soule & Soule, 1973

Pl. 21.

cf. *Smittoidea pacifica* Soule & Soule, 1973, p. 380, figs. 1E-H; Winston, 1986, p. 28; Ryland & Hayward, 1992, p. 268, fig. 24e, f; Tilbrook, Hayward & Gordon, 2001, p. 78, fig. 18E; Tilbrook, 2006, p. 177, pl. 38, figs. A-B.

Figured material – NHMUK BZ PI 6926, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula similar to later autozooids but smaller, 325 μm long by 170 μm wide (Fig. 1a). First generation of autozooids smaller in size (300-360 μm long by 200-230 μm wide) than later budded autozooids (Fig. 1a). Autozooids distinct with shallow interzooidal furrows, quincuncially arranged, hexagonal or irregularly polygonal, longer than broad (mean L/W = 1.58) (Fig. 1b). Frontal shield flat or slightly convex, coarsely nodular, with a single series of large (D = 25-35 μm), conspicuous marginal areolar pores (Fig. 1b). Primary orifice seemingly subcircular, about 100 μm in diameter, with a wide anvil-shaped lyrula, occupying almost the entire proximal border (Fig. 1c); distal border rounded, smooth; condyles not seen. Oral spines absent. Secondary orifice completely encircled by the peristome with thick edges and a conspicuous U-shaped medioproximal pseudosinus (Fig. 1d). Single suboral avicularium on each autozooid, rostrum elongated triangular, with rounded tip, lateral edges finely denticulate, complete crossbar, proximally directed (Fig. 1e). Ooecia globular, broader than long, 130 μm long by 210 μm wide, cover of smooth calcification extending peripherally from the distal border of the peristome (Fig. 1d); central frontal area occupied by a circular fenestra with a few scattered irregularly-shaped pores.

Measurements – ZL 474±12, 458-488 (1, 10); ZW 300±28, 278-345 (1, 10); AL 97±4, 93-104 (1, 10).

Remarks – A single small colony of *Smittoidea* cf. *pacifica* has been discovered on a late Burdigalian platy coral. Similarities between the Kalimantan specimen and the Recent *Smittoidea pacifica* are striking. However, a better preserved ooecium and orifice are needed to demonstrate that they are conspecific. *Smittoidea pacifica* typically encrusts the undersides of corals (Winston, 1986), and has been described from Venezuela, Galapagos and Hawaii (Winston, 1986), the Great Barrier Reef (Hayward & Ryland, 1992), Vanuatu (Tilbrook *et al*., 2001) and the Solomon Islands (Tilbrook, 2006). Soule & Soule (1973, p. 382) noted that some of Harmer's *Siboga* material attributed to *Smittina levis* might be included in *Smittoidea pacifica*.

Superfamily Schizoporelloidea Jullien, 1883
Family Schizoporellidae Jullien, 1883
Genus *Stylopoma* Levinsen, 1909

Stylopoma sp. 1
Pl. 22.

Figured material – NHMUK PI BZ 6928, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, multilaminar. Ancestrular complex not observed. Autozooids with distinct interzooidal furrows, quincuncially arranged, hexagonal or irregularly polygonal, slightly longer than broad (mean L/W = 1.19). Frontal shield flat or slightly convex, evenly and densely perforated with small round pseudopores surrounded by rims of thickened calcification (Fig. 1b, e); marginal pores not seen. Primary orifice wider than long, about 70 μm long by 130 μm wide (excluding sinus), transversely D-shaped, proximal edge straight; sinus deep, narrow, U-shaped (Fig. 1c); condyles rectangular, deep and wide, smooth, with rounded median edges, occupying the majority of the proximal border on each side of the sinus. Ooecia globular, prominent, 350 μm long by 320 μm wide, calcified endooecium widely exposed, densely perforated (Fig. 1d); aperture not observed. One, small (L = 35 μm), teardrop-shaped adventitious avicularium, located proximolateral of the orifice and medially directed (Fig. 1e, f); rostrum short, acute, triangular; crossbar and condyles not seen. Vicarious avicularia not observed.

Measurements – ZL 526±20, 494-550 (1, 10); ZW 442±27, 385-467 (1, 10).

Remarks – A single poorly preserved colony of *Stylopoma* sp. 1 encrusts the underside of a Serravallian platy coral from Batu Putih. The genus *Stylopoma* has a pantropical distribution in shallow, generally reefal habitats. Tilbrook (2001) described and illustrated twenty-one Recent species of *Stylopoma* from the Indo-West Pacific and indicated a number of criteria that can be used to distinguish between the individual species. The poor preservation of the Kalimantan specimen prevents the observation of some of these diagnostic features such as the ancestrular complex and ooecium aperture.

Stylopoma sp. 2
Pl. 23.

Figured material – NHMUK PI BZ 6929, early Tortonian, TF508, Bontang.

Description – Colony encrusting, multiserial, multilaminar. Ancestrular complex not observed. Autozooids distinct with raised lateral walls, frontally budded zooids irregularly arranged, rhomboidal or irregularly polygonal, slightly longer than broad (mean L/W = 1.1) (Fig. 1b). Frontal shield flat or slightly convex, evenly and densely perforated with large round pseudopores surrounded by rims of thickened calcifica-

tion (Fig. 1b, d); a single row of oval areolar pores, larger than the pseudopores, along the zooidal margin. Primary orifice slightly longer than wide (including sinus); anter transversely D-shaped, proximal edge straight or concave; sinus shallow, wide, U-shaped; condyles small, rectangular, smooth, rounded (Fig. 1c). Closure plates common, smooth, depressed centrally, with a slightly raised umbo proximally (Fig. 1d, e). Adventitious avicularia small, paired, placed lateral to the orifice, distomedially directed; rostrum elongate, acute, triangular or falciform (Fig. 1c, e); crossbar complete. Vicarious avicularia not observed. Ooecia globular, prominent, 420 μm long by 370 μm wide, coarsely granular and nodular, perforated proximally (Fig. 1f); aperture not observed.

Measurements – ZL 821±52, 749-871 (1, 10); ZW 771±52, 704-828 (1, 10); OL 197±13, 171-214 (1, 10); OW 187±22, 152-219 (1, 10); AL 197±15, 183-220 (1, 10).

Remarks – A single well-preserved multilaminar colony of *Stylopoma* sp. 2 completely encrusts a small mollusc shell fragment, 5 mm in diameter, from the early Tortonian. It differs from *Stylopoma* sp. 1 in having larger zooids with larger pseudopores, distinct areolar pores, a much larger sinus and paired falciform avicularia distomedially directed. Similarly shaped adventitious avicularia, though single and distally directed, have been described in Recent *Stylopoma falcifera* (Canu & Bassler, 1928) from the Caribbean. However, the lack of vicarious avicularia and the scarcity of available material prevent any further comparisons as well as the introduction of a new species.

***Stylopoma* sp. 3**

Pl. 24.

Figured material – NHMUK PI BZ 6930, Messinian, TF511, 'Sekarat Top Reef', Sangkulirang.

Description – Colony encrusting, multiserial, multilaminar. Ancestrular complex not observed. Autozooids with distinct interzooidal furrows, quincuncially arranged, hexagonal or irregularly polygonal, slightly longer than broad (mean L/W = 1.15) (Fig. 1b). Frontal shield flat or slightly convex, evenly and densely perforated with round pseudopores (Fig. 1c); marginal pores distinct only at corners. Primary orifice, wider than long (including sinus), transversely D-shaped, proximal edge straight; sinus shallow, U-shaped, occupying one-third of the proximal border (Fig. 1d); condyles not seen. Adventitious avicularium single, oval, small, 70-80 μm long, located proximolaterally of orifice and directed distolaterally (Fig. 1c, d); crossbar and condyles not seen. Vicarious avicularia and ooecia not observed.

Measurements – ZL 550±56, 467-668 (1, 30); ZW 478±52, 376-536 (1, 30); OL 98±9, 83-110 (1, 30); OW 134±7, 121-143 (1, 30).

Remarks – A single colony of *Stylopoma* sp. 3 encrusts the base of a Messinian platy coral. Although extensive, the colony lacks vicarious avicularia and ooecia. Additionally, the poor preservation prevents the complete description of some characters, such

as the orificial condyles and pivotal bars of the adventitious avicularium. *Stylopoma* sp. 3 differs from *S.* sp. 1 and *S.* sp. 2 in the shape and orientation of the adventitious avicularia. In Messinian *Stylopoma* sp. 3 adventitious avicularia are single, oval, and distolaterally directed, whereas in Serravallian *S.* sp. 1 they are teardrop-shaped with an acute rostrum directed medially, and in early Tortonian *S.* sp. 2 they are paired, triangular or falciform and directed distomedially. The general appearance of *Stylopoma* sp. 3 resembles Recent *S. consobrina* Tilbrook, 2006, from the Solomon Islands.

Family Margarettidae Harmer, 1957
Genus *Margaretta* Gray, 1843

Margaretta aff. *gracilior* (Ortmann, 1892)
Pl. 25, fig. 1a-d.

aff. *Margaretta gracilior* Harmer, 1957, p. 835, pl. 55, figs. 23-28; Tilbrook, 2006, p. 234, pl. 51, fig. D.

Figured material – NHMUK PI BZ 6931, BZ 6932, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, articulated. Internodes cylindrical, straight or slightly curving, narrow, about 0.4-0.5 mm wide, quadriserial. Basis rami narrow (*c.* 0.2-0.3 mm), tubular, undivided. Autozooids in whorls of two, elongate; zooidal boundaries indistinct. Frontal shield convex, regularly and evenly perforated by small, sunken, circular pores situated at the centre of a polygonal mesh; ascopore disto-medial, distance to proximal orifice margin slightly more than orifice length, somewhat larger than a pseudopore and encircled by a ridge that does not project above the zooidal surface. Aperture semicircular or slit-like. Peristome extremely reduced to a proximo-median projection, not delimited by a basal ridge. Brooding zooids not seen.

Measurements – ZL 955±40, 891-992 (5, 50); ZW 392±18, 379-405 (5, 50); OL 71±25, 44-93 (5, 30); OW 157±3, 156-161 (5, 30).

Remarks – Internodes of *Margaretta* aff. *gracilior* are scattered abundantly in muddy-silty sediments of the late Burdigalian '3D Reef', along with another species of *Margaretta*, *M.* aff. *tenuis* (see below). *Margaretta* is a common and abundant component of the Recent Indo-Pacific bryofauna. Harmer (1957), reported five species from the *Siboga* material, *M. opuntioides* (Pallas, 1766), *M. watersi* (Canu & Bassler, 1929), *M. gracilior* (Ortmann, 1892), *M. tenuis* Harmer, 1957, and *M. triplex* Harmer, 1957, which, however, appears to be a junior synonym of *M. chuakensis* (Waters, 1907) (Tilbrook, 2006). In addition, Tilbrook (2006) described a new species from Solomon Islands, *M. longicollis*. Three Cenozoic species have been also described from India, *M. turgida* (Tewari & Srivastava, 1967) from the Eocene, and *M. fusiformis* Guha & Gopikrishna, 2007, and *M. rajui* Guha & Gopikrishna, 2007, from the Miocene.

Species of *Margaretta* are distinguished using characters including the number of autozooids in a whorl, the number of articulation tubes, peristome morphology, the position of the ascopore, and the shape of pores in the frontal shield. Four species of

Margaretta have been found in samples from Kalimantan, two in the late Burdigalian, *M.* aff. *gracilior* and *M.* aff. *tenuis*, one new species, *M. amitabhae* sp. nov., extending from the Burdigalian-Langhian boundary to the Serravallian, and *M.* aff. *watersi* in Serravallian. *M.* aff. *gracilior* is similar to the nominal species, as described by Harmer (1957) and Tilbrook (2006), in the size of internodes and autozooids, in having two autozooids in a whorl with short inclined peristomes and indistinct lateral walls, a disto-medial ascopore rimmed distally and laterally, and a frontal shield regularly perforated by small, sunken pores. However, the peristomes in the fossil species are almost entirely reduced compared to the Recent material, and the aperture is smaller, while the polygonal network of calcification characterizing the frontal shield is much more obvious in the fossils.

***Margaretta* aff. *tenuis* Harmer, 1957**

Pl. 25, fig. 2a-c.

aff. *Margaretta tenuis* Harmer, 1957, p. 840, pl. 55, figs. 13-18.

Figured material – NHMUK PI BZ 6933, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony erect, articulated. Internodes cylindrical, straight or slightly curving, about 0.6-0.8 mm wide, 6 zooidal series. Basis rami tripartite (Fig. 2c), originating at the side of a peristome, raised. Autozooids in whorls of three, outline distinct with shallow interzooidal furrows, elongate (mean L/W = 3.22), oval, tapering proximally. Frontal shield convex, smooth, regularly and evenly perforated by small, circular pores arranged in longitudinal rows; ascopore disto-medial, located immediately proximally of the peristomial ridge, large, surrounded by a slightly raised rim most developed distally and laterally (Fig. 2b). Aperture semicircular (Fig. 2c). Peristome moderately developed, longer proximally than distally, perpendicular to frontal shield, ridged, ridges projecting frontally to give the appearance of a denticulate oral rim, valleys between ridges porous, basal ridge distinct (Fig. 2b, c). Brooding zooids not seen.

Measurements – ZL 955±40, 891-992 (5, 50); ZW 392±18, 379-405 (5, 50); OL 71±25, 44-93 (5, 30); OW 157±3, 156-161 (5, 30).

Remarks – Internodes of *Margaretta* aff. *tenuis* are common and abundant, along with internodes of *M.* aff. *gracilior,* in late Burdigalian sediments. These two species are easily distinguishable, even by the naked eye, as the internodes are wider and more robust in the former species. *M.* aff. *tenuis* differs from *M.* aff. *gracilior* also in having a different number of zooids in a whorl (3 vs. 2), in the appearance of the frontal shield, with small, circular pores in longitudinal rows instead of pores at the centres of polygons of calcification, and in the presence of a peristomial ridge. This species is similar to *M. tenuis* in having the same number of autozooids in a whorl, tripartite articulation, distinct zooidal boundaries, a distinct peristomial ridge, the moderate, ridged peristome, and the ascopore adjacent to the peristomial ridge. However, it differs in having a semicircular rather than circular secondary orifice.

Margaretta aff. *watersi* (Canu & Bassler, 1930)

Pl. 26, fig. 1a-d.

aff. *Margaretta watersi* Harmer, 1957, p. 838, pl. 55, figs. 3, 6, 7.

Figured material – NHMUK PI BZ 6934, BZ 6935, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony erect, articulated. Internodes cylindrical, straight or slightly curving, 0.8-1.2 mm wide (Fig. 1a, c), 8 zooidal series. Basis rami narrow (*c*. 0.3-0.4 mm), tubular, bipartite, originating between two peristomes. Autozooids in whorls of four, elongate; zooidal boundaries indistinct. Frontal shield convex, granular, regularly and evenly perforated by small, sunken, circular pores situated at the centres of a polygonal meshwork of calcification (Fig. 1b, d); ascopore disto-medial, situated at the middle of a triangle formed by three orifices, slightly larger than pseudopores, surrounding ridge not projecting above zooidal surface. Aperture circular, 165-190 μm in diameter. Peristome short, perpendicular to the frontal plane, not delimited by a basal ridge. Brooding zooids with longer peristomes, inclined distally, bulbous at base (Fig. 1d).

Measurements – ZL 1525±55, 1426-1573 (5, 40); ZW 597±35, 553-661 (5, 40).

Remarks – Internodes of *Margaretta* aff. *watersi* are common and abundant in several sections, from Batu Putih to the Stadion Reef, all Serravallian in age. It is similar to the specimens recorded by Harmer (1957) under this name in having the ascopore placed at the middle of a triangle formed by three apertures, and fertile peristomes that are long and distally curved, but differs in having a bipartite instead of undivided articulation. It also differs from the previously described species mainly in the number of zooids in a whorl, which are four in *M.* aff. *watersi*, three in *M.* aff. *tenuis*, and two in *M.* aff. *gracilior.*

Margaretta amitabhae sp. nov.

Pl. 26, fig. 2a-c.

Figured material – Holotype: NHMUK PI BZ 6937, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang. Paratype: NHMUK PI BZ 6938, same details as holotype.

Etymology – Named after the south-east Asian mythological goddess Amitabh.

Diagnosis – Colony erect, articulated. Internodes formed by pairs of back to back zooids. Articulation undivided. Autozooids club-shaped. Frontal shield granular, perforated. Ascopore disto-medial. Aperture subcircular. Peristome moderate. Brooding zooids with longer peristomes.

Description – Colony erect, articulated. Internodes straight or slightly curved, as wide as a zooid, formed by single pairs of back-to-back zooids. Articulation undivided,

originating laterally, between two peristomes. Autozooids club-shaped, tapering and bottleneck-shaped distally, elongate (mean L/W = 2.09) (Fig. 2a-c); zooidal boundaries distinct. Frontal shield convex, granular, regularly and evenly perforated by small, sunken, circular pores in furrows between longitudinal ridges continuing into the peristome; ascopore disto-medial, surrounded by a raised rim most developed proximally and laterally (Fig. 2b). Aperture subcircular, about 100 μm in diameter. Peristome moderately developed, about 0.3 mm long, angled at approximately 45° to the frontal shield, ridged, ridge projections giving the appearance of a denticulate apertural rim, delimited by a basal ridge (Fig. 2a-c). Brooding zooids with longer peristomes, 0.4-0.5 mm long, inflated proximally, 0.35-0.40 mm wide at the base (Fig. 2c).

Measurements – ZL 1026±66, 958-1124 (15, 30); ZW 492±32, 453-530 (15, 30).

Remarks – Disarticulated internodes of *Margaretta amitabhae* sp. nov. have been found in Burdigalian-Langhian and Serravallian sediments. The shape and arrangement of the internodes is very peculiar and distinguishes this species from all known Recent and fossil species of *Margaretta*. However, specimens similar to the Kalimantan species have been found also in samples from the Miocene of Tanzania (B. Berning, research in progress).

Family Hippopodinidae Levinsen, 1909
Genus *Hippopodina* Levinsen, 1909

***Hippopodina feegeensis* (Busk, 1884)**
Pl. 27.

Lepralia feegeensis Busk, 1884, p. 144, pl. 22, figs. 9, 9a, 9b.
Hippopodina feegeensis Harmer, 1957, p. 974, pl. 67, figs. 8-9; Ryland & Hayward, 1992, p. 256, fig. 17a; Tilbrook, 1999, p. 451, fig. 1a-h.

Figured material – NHMUK PI BZ 6939, Serravallian, TF51, 'Stadio Reef 1', Samarinda; NHMUK PI BZ 6940, early Tortonian, TF508, Bontang.

Description – Colony encrusting, multiserial, unilaminar, often very extensive. Ancestrula and early astogeny not observed. Autozooids large, distinct, with deep interzooidal furrows, rectangular or hexagonal, slightly longer than broad (mean L/W = 1.31) (Fig. 1a, b). Frontal shield convex, tuberculate, evenly perforated by numerous small pseudopores. Orifice hoof-shaped, slightly longer than wide, a pair of small, rounded, lateral condyles directed medially and separating a rounded anter from a smaller poster with a straight or slightly concave proximal margin (Fig. 1c). Adventitious avicularia generally paired, though sometimes single, located distolaterally of orifice and orientated medially (Fig. 1b, c); rostrum pointed, acutely triangular, raised; crossbar complete. Ooecium very large, almost as long as wide, rounded, evenly perforated (Fig. 1d). Orifice in ovicellate zooids shorter but wider than autozooids, about 170 μm long by 260 μm wide. Avicularia not visible in ovicellate zooids.

Measurements – ZL 809±33, 751-856 (5, 40); ZW 616±38, 577-668 (5, 40); OL 222±22, 195-230 (5, 40); OW 199±20, 177-242 (5, 40); AL 234±25, 199-273 (5, 40); OvL 551±8, 547-557 (5, 20); OvW 568±31, 539-600 (5, 20).

Remarks – *Hippopodina feegeensis* is common and abundant in all of the Serravallian and Tortonian samples, where it has been found encrusting extensively the undersides of platy corals. At the present day *H. feegeensis* has a circumtropical distribution in warm shallow waters within the 21°C surface water isotherm, forming very broad encrusting sheets on all kinds of substrates, often occurring on coral rubble (Tilbrook, 1999). Tilbrook (1999) pointed out the large morphological variation of this species in, for example, the shape of the proximal orifice margin, which is seemingly geographically or habitat-related, and which, in Tilbrook's opinion, does not warrant the erection of separate species. Some differences can be observed in the Kalimantan material between Serravallian and Tortonian colonies. In the Serravallian colonies the proximal margin of the orifice is straight whereas in the Tortonian colonies it is concave. Furthermore, the fossil specimens show generally smaller autozooids (0.81 × 0.62 mm) than material from the Recent of the Philippines (0.98 × 0.62 mm), Australia (1.01 × 0.63 mm), Fiji (0.98 × 0.58 mm) and the Red Sea (1.07 × 0.73 mm) (Tilbrook, 1999).

Hippopodina cf. *pulcherrima* (Canu & Bassler, 1928)

Pl. 28.

cf. *Lepralia pulcherrima* Canu & Bassler, 1928, pp. 25, 82, pl. 6, figs. 1-2.
cf. *Hippopodina feegeensis* Harmer, 1957, p. 974, pl. 67, fig. 7.
cf. *Hippopodina pulcherrima* Tilbrook, 1999, p. 452, fig. 1g, h; Tilbrook, 2006, p. 246, pl. 54, figs. A-B.

Figured material – NHMUK PI BZ 6941, Messinian, TF511, 'Sekarat Top Reef', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids large, distinct, with deep interzooidal furrows, rectangular or hexagonal, longer than broad (mean L/W = 1.52). Frontal shield convex, tuberculate, evenly perforated by numerous small pseudopores (Fig. 1b, c). Orifice hoof-shaped, slightly longer than wide, a pair of small, rounded, lateral condyles separating a rounded anter from a smaller poster with a concave proximal margin. Ooecium large, about 740 μm long by 670 μm wide, rounded, evenly perforated (Fig. 1c). Adventitious avicularia generally single, sometimes paired, located proximolaterally of orifice and orientated proximomedially (Fig. 1d); rostrum raised, acutely triangular; crossbar complete. Avicularium and orifice morphology not observed in ovicellate zooids.

Measurements – ZL 1019±23, 1003-1046 (2, 20); ZW 672±26, 639-706 (2, 20); OL 293±15, 277-316 (2, 20); OW 274±17, 252-291 (2, 20); AL 298±9, 285-308 (2, 20).

Remarks – Two colonies of *Hippopodina* cf. *pulcherrima* have been found encrusting branches of Messinian *Porites*. At the present day *H. pulcherrima* has been described

from the Caribbean, tropical western Atlantic, the Red Sea and the Solomon Islands (Tilbrook, 2006). The zooidal size of the Kalimantan specimens is slightly smaller than the Recent.

Hippopodina indicata sp. nov.

Pl. 29.

Figured material – Holotype: NHMUK PI BZ 6942, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Referring to its avicularia pointing towards the orifice.

Diagnosis – Colony encrusting. Autozooids rectangular or hexagonal. Frontal shield tuberculate, evenly perforated except around the orifice. Orifice hoof-shaped. Adventitious avicularia single or lacking, triangular. Ooecium globular, evenly perforated.

Description – Colony encrusting, multiserial, unilaminar, often very extensive. Ancestrula and early astogeny not observed. Autozooids large, distinct, with deep interzooidal furrows, rectangular or hexagonal, slightly longer than broad (mean L/W = 1.37). Frontal shield convex, tuberculate, evenly perforated by numerous moderately large pores except for in a smooth area around the orifice (Fig. 1a, b). Orifice hoof-shaped, slightly longer than wide, a pair of small, rounded, lateral condyles directed downwards and separating a rounded anter from a smaller poster with a concave proximal margin; distal edge of oral rim raised slightly (Fig. 1d). Adventitious avicularia often single, sometimes lacking, never observed paired, originating laterally on the distal third of the zooid, orientated distomedially (Fig. 1a-c); rostrum raised, acutely triangular, pointing towards the orificial condyles; crossbar complete. A single crushed ooecium, probably originally globular, about 400 μm long by 600 μm wide, evenly perforated (Fig. 1c). Orifice in ovicellate zooid obscured. Avicularium present in ovicellate zooid.

Measurements – ZL 1206±36, 1178-1257 (5, 50); ZW 883±41, 800-936 (5, 50); OL 320±24, 281-347 (5, 30); OW 285±33, 246-319 (5, 30); AL 410±30, 388-431 (5, 30).

Remarks – A fair number of large colonies of *Hippopodina indicata* sp. nov. have been found encrusting the undersides of platy corals in late Burdigalian to Langhian deposits. A single colony was fertile, but unfortunately the roof of the ooecium is crushed. It differs from the Kalimantan species assigned to *Hippopodina feegeensis* and *H.* cf. *pulcherrima* in having the frontal shield perforated by fewer and much larger pores, and adventitious avicularia positioned more proximolaterally compared to the former species and distomedially rather than proximomedially directed as in the latter species. It also differs from Recent *H. pectoralis* Harmer, 1957, from the Celebes Sea and from the French Miocene species *H. lappi* David, 1965, in having adventitious avicularia, and from the Spanish Pliocene species *H. iberica* Pouyet, 1976, in having the frontal shield perforated by large circular pores, not polygonal, and in the number, position and size of the adventitious avicularia which are always paired, small and distally placed in *H. iberica*.

Genus *Saevitella* Bobies, 1956

Saevitella renemai sp. nov.

Pl. 30.

Figured material – Holotype: NHMUK PI BZ 6943, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after Willem Renema (NCB Naturalis, Leiden, The Netherlands) for his support during the fieldwork.

Diagnosis – Colony encrusting. Autozooids oval or polygonal. Frontal shield finely tuberculate, evenly perforated. Orifice dimorphic. Ooecia immersed.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, oval or irregularly polygonal, elongate (mean L/W = 1.62). Frontal shield convex, finely tuberculate, evenly perforated by numerous small circular pores (Fig. 1b). Orifice surrounded by a narrow and smooth rim, dimorphic: in non-ovicellate zooids oval, small, longer than wide, averaging 170 × 130 μm, with concave proximal margin (Fig. 1b); in ovicellate zooids much more rectangular, about 200 μm wide by 150 μm long, with straight proximal margin (Fig. 1d); condyles small. Ooecia subimmersed in frontal shield of one or between two distal zooids, globular, small, wider than long, more tuberculate and less perforated than the frontal shield (Fig. 1c, d).

Measurements – ZL 644±34, 614-676 (2, 30); ZW 397±25, 353-426 (2, 30); OvL 174±15, 156-195 (2, 20); OvW 271±21, 244-294 (2, 20).

Remarks – A few small colonies of *Saevitella renemai* sp. nov. have been discovered on the bases of late Burdigalian platy corals. The Kalimantan species differs from coeval European *S. inermis* Bobies, 1956, in lacking a wide non-porous lip around the orifice, and in having much more numerous and smaller pores perforating the frontal shield. Recent *S. peristomata* (Waters, 1899) from Madeira is characterized by a raised peristome absent in the Kalimantan species. This is the first record of the genus from the Indo-West Pacific region. It was hitherto known only from the Miocene to Recent of the Atlanto-Mediterranean region (cf. Berning, 2012, for a recent account of the genus and its species).

Genus *Thornelya* Harmer, 1957

Thornelya sp.

Pl. 31.

Figured material – NHMUK PI BZ 6944, Serravallian, TF57, 'Stadion Reef 2', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with shallow interzooidal furrows, arranged in alternating longitudinal rows, rectangular, varying in size, generally longer than broad (mean L/W = 1.14), sometimes wider than long. Frontal shield convex, tuberculate, perforated by 50-60 large circular pores, mean diameter 30 μm (Fig. 1b). Orifice placed distally, slightly dimorphic, oval, a little longer than wide with shallow concave proximal sinus and rounded condyles medially directed in non-ovicellate zooids (Fig. 1d), subcircular, slightly wider than long in ovicellate zooids (Fig. 1b). Oral spine bases of an uncertain number, probably two, distolateral, widely spaced. Ooecium globular, wider than long, 250 μm long by 360 μm wide, subimmersed in frontal shield of the distal zooid, with similar perforations to those of the frontal shield (Fig. 1b). Up to four adventitious avicularia per zooid, 50-110 μm long, oval or triangular, with rounded or acute rostrum, placed latero-oral or along zooidal margins, usually at mid-length or on the proximal margin, distolaterally or proximally directed, on a small, smooth, raised cystid (Fig. 1c).

Measurements – ZL 517±74, 432-619 (1, 20); ZW 452±87, 369-580 (1, 20); OL 136±7, 127-141 (1, 10); OW 128±7, 118-136 (1, 10).

Remarks – A single colony of *Thornelya* sp. has been found encrusting the base of a Serravallian platy coral. Three Recent Indo-Pacific species of *Thornelya* have been previously described: *T. ceylonica* (Thornely, 1905), *T. fuscina* Tilbrook, Hayward & Gordon, 2001, and *T. perarmata* Harmer, 1957. The Kalimantan species has evenly and densely perforated frontal shields, which makes it easily distinguishable from *T. perarmata* that has pseudopores concentrated centrally and larger, distinct marginal areolar pores. *T. ceylonica* and *T. fuscina* are very similar in general appearance, differing in the number of oral spines and avicularia, and in the size and shape of the orifice. *T. fuscina* shares with the fossil species the presence of three perioral avicularia (two latero-oral and one on the proximal margin of the distal zooid) seen in some of the zooids.

Family Gigantoporidae Bassler, 1935
Genus *Gigantopora* Ridley, 1881

Gigantopora milenae sp. nov.
Pl. 32.

Figured material – Holotype: NHMUK PI BZ 6945, Serravallian, TF57, 'Stadion Reef 2', Samarinda. Paratype: NHMUK PI BZ 6946, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Etymology – Named after a good friend of the first author, Milena Crespi.

Diagnosis – Colony encrusting. Ancestrula discoidal with an extensive frontal shield. Autozooids rectangular or rhomboidal. Frontal shield porous with pointed frontal processes. Primary orifice obscured by a tall peristome; secondary orifice elliptical. Avicularia paired, lateral to orifice, medially directed. Spiramen transversely oval or reniform. Ooecium cap-like, laterally compressed, ridged and perforated.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula large, about 400 μm long by 300 μm wide, discoidal, frontal shield faintly granular, with a small, distal, circular aperture (Fig. 1e); a single zooid budded distally, much smaller than later autozooids, about 350 μm long by 200 μm wide. Autozooids distinct with deep interzooidal furrows, quincuncially arranged, rectangular or rhomboidal, longer than broad (mean L/W = 1.72). Frontal shield convex, with numerous, very small pseudopores between raised, pointed frontal processes (Fig. 1a, b). Primary orifice often obscured by a tall, frontally curved, thin peristome, a wide sinus with two triangular rounded condyles visible in one autozooid; secondary orifice elliptical, transversely elongate. Peristomial bridge over spiramen with more rounded tubercles than on the frontal shield, presence of perforations unclear; spiramen transversely oval or reniform, similar in size to secondary orifice, 1.5 times as wide as long (Fig. 1b). Ooecium small, globular, but laterally compressed, cap-like on the peristome, slightly longer than wide, ridged and perforated by a few pores, larger than in the frontal shield and irregularly distributed (Fig. 1c). Avicularia paired, small, about 60 μm long, located laterally of orifice, medially directed (Fig. 1d); crossbar complete.

Measurements – ZL 606±29, 573-640 (2, 30); ZW 353±16, 334-366 (2, 30); OL 112±15, 91-133 (2, 30); OW 182±11, 167-201 (2, 30); OvL 217±9, 205-224 (2, 10); OvW 195±18, 174-215 (2, 10).

Remarks – *Gigantopora milenae* sp. nov. is common in the Serravallian, even though not abundant, occurring as small encrusting colonies on the bases of platy corals. This species is characterised by the relatively small size of the zooids, the small, irregularly perforate and ridged ooecia, and the small, triangular, medially directed peristomial avicularia. Three Recent species of *Gigantopora* have been described or reported by Harmer (1957) from Indonesia: *G. profunda* Harmer, 1957, which mainly differs from *Gigantopora milenae* sp. nov. in colony morphology, being erect instead of encrusting; *G. pupa* (Jullien & Calvet, 1903), which differs from the Kalimantan species in having much larger zooids (1.3 × 0.7 mm vs 0.6 × 0.4 mm), a larger ooecium completely encircling the peristome laterally and distally, and rounded instead of pointed tubercles on the frontal shield; and *G. spiculifera* Canu & Bassler, 1927, which has a larger, less tuberculate ooecium and characteristic minute frontal tubercles that divide at their ends. Fossil occurrences of the genus *Gigantopora* are uncommon. Hayward & Winston (2011, p. 2304) stated that "species of *Gigantopora* have been described from Tertiary horizons in New Zealand" without mentioning the source, but Gordon (1984, p. 79) described *Gephyrophora polymorpha* Busk, 1884, from the Kermadec Ridge, which appears to be an encrusting form of *G. polymorpha* recorded by Brown (1952) from the Middle Oligocene of New Zealand, and which was placed in *Gigantopora* by the latter author.

Family Lanceoporidae Harmer, 1957
Genus *Calyptotheca* Harmer, 1957

Calyptotheca sp. 1
Pl. 33, fig. 1a-d.

Figured material – NHMUK PI BZ 6947, Serravallian, TF76, 'Batu Putih 1', Samarinda; NHMUK PI BZ 6948, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula, early astogeny and basal pore chambers not observed. Autozooids distinct, bordered by a thin calcified lining, hexagonal or irregularly polygonal, longer than broad (mean L/W = 1.30). Frontal shield convex, perforated by 20-30 fairly large, round pores, mean diameter 35 μm (Fig. 1a, c). Orifice distally placed, oval, slightly wider than long, with concave proximal sinus (Fig. 1c, d); condyles small and rounded. Ooecium globular, wider than long, recumbent on and occupying most of the distal zooid frontal shield with similar perforations to those of the frontal shield (Fig. 1d). Avicularia absent.

Measurements – ZL 537±18, 524-550 (1, 10); ZW 414±18, 402-427 (1, 10); OL 147±3, 144-149 (1, 10); OW 163±5, 160-169 (1, 10); OvL 224±20, 204-242 (1, 7); OvW 333±7, 326-340 (1, 7).

Remarks – Seven colonies of *Calyptotheca* sp. 1 encrust platy coral fragments, one from the late Burdigalian, the other six from the Serravallian. This species is characterised by the distribution and size of the frontal pores, which are few in number, but large compared to established species of *Calyptotheca*, and by the lack of avicularia. The Oligo-Miocene species *C. subhexagonalis* Guha & Gopikrishna, 2007, and *C. subrectangulata* Guha & Gopikrishna, 2007, from Gujarat, India, Recent *C. suluensis* Harmer, 1957, from the Sulu Archipelago and *C. rugosa* from the Mediterranean also lack avicularia. However, they all differ from the Kalimantan species in frontal shield porosity.

Calyptotheca sp. 2
Pl. 33, fig. 2a, b.

Figured material – NHMUK PI BZ 6949, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula, early astogeny and basal pore chambers not observed. Autozooids distinct with deep interzooidal furrows, irregularly polygonal, longer than broad (mean L/W = 1.29). Frontal shield convex, granular, perforated by 25-35 small, round pores, mean diameter 15 μm (Fig. 2a). Orifice distally placed, oval, longer than wide, with proximal sinus; condyles not seen. Peristome raised, flared proximally, bearing two latero-oral avicularia, small, oval and distally directed (Fig. 2b). Ooecium globular, partly immersed in the frontal shield of the distal zooid, wider than long, perforated (Fig. 2b); pores smaller than those on the frontal walls.

Measurements – ZL 488±53, 437-566 (1, 10); ZW 378±20, 354-414 (1, 10); OL 154±11, 141-163 (1, 3); OW 105±9, 95-114 (1, 3); OvL 212±12, 197-227 (1, 5); OvW 264±9, 256-277 (1, 5); AL 74±5, 68-80 (1, 5).

Remarks – A single colony of *Calyptotheca* sp. 2 encrusts a Serravallian platy coral. It differs from *C.* sp. 1 in the size of the frontal pores and in having latero-oral, peristomial avicularia. *C. parcimunita* Harmer, 1957, has paired avicularia resembling those of the fossil species, although wanting in ovicellate zooids, but differs in the shape of the orifice, which is approximately as long as wide in *C. parcimunita* and more elongate in *C.* sp. 2.

Family Actisecidae Harmer, 1957
Genus *Actisecos* Canu & Bassler, 1927

Actisecos sp. 1
Pl. 34.

Figured material – NHMUK PI BZ 6950, BZ 6951, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony ?free-living, discoidal, small, measuring 1.5-2 mm in diameter, almost flat or slightly convex frontally and slightly concave basally (Fig. 1a, d). Basal surface with depressions (Fig. 1d). Ancestrula broken. Autozooids distinct with shallow interzooidal furrows, arranged regularly in alternating circlets, rhomboidal, longer than broad (mean L/W = 1.20). Frontal shield convex, granular, perforated by 10-15 moderately large, round pores (Fig. 1b). Peristome raised, tubular, granular, imperforate. Avicularia absent. Ooecium globular, small, peristomial, placed on the basal side of, and slightly wider than the peristome, barely visible in frontal view as a small semicircular cap, porous (Fig. 1b, c).

Measurements – ZL 380±23, 328-410 (2, 20); ZW 316±18, 296-357 (2, 20).

Remarks – Two small colonies, formed by three circlets of zooids, of *Actisecos* sp. 1 have been found in late Burdigalian sediments. The genus *Actisecos* includes two Recent species characteristic of muddy-sandy sea-bottoms: *A. pulcher* Harmer, 1957, described from the Makassar Strait and Java Sea at 59-88 m depth, and *A. regularis* Canu & Bassler, 1927, described originally from the Philippines at 84-104 m depth. The latter has been reported by Harmer (1957) from the Java Sea at 82-88 m depth, and by Cook (1966) from New Guinea and Gulf of Oman at 201 m depth. The former species has much larger and more convex colonies, and considerably larger ooecia than the latter. The Kalimantan species, with its nearly flat colonies and very small ooecia, seems to be more similar to *A. regularis*. The fossil specimens have much smaller zooids than those reported by Cook (1966, p. 208). Harmer (1957, p. 859) described a moderate number of foramina surrounded by a low circular wall on the basal surface of both *A. pulcher* and *A. regularis*, which are interpreted as rootlet-chambers allowing colonies potentially to be attached to the substrate by rootlets. Similar structures can be observed in *A.* sp. 1. In contrast, Cook (1966, p. 208) described *Actisecos* as "apparently completely free-living".

***Actisecos* sp. 2**
Pl. 35.

Figured material – NHMUK PI BZ 6952, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony ?free-living, hemispherical, small, measuring 2-3.5 mm in diameter, strongly convex frontally, concave basally (Fig. 1a). Basal surface with depressions. Ancestrula broken, leaving an oval depression surrounded by six periancestrular zooids (Fig. 1b). Autozooids distinct with deep interzooidal furrows, arranged regularly in alternating circlets, oval, longer than broad (mean L/W = 1.42). Frontal shield convex, perforated by 10-12 large, round pores in raised, conical processes (Fig. 1c). Peristome raised, tubular, coarsely tuberculate, imperforate. Ooecium globular, large, peristomial, placed on the basal side of peristomes of marginal zooids, wider than the peristome, porous (Fig. 1c). Avicularia absent.

Measurements – ZL 480±37, 395-541 (2, 30); ZW 337±22, 290-376 (2, 30).

Remarks – Four small colonies of *Actisecos* sp. 2 have been found in silty sediments from the Serravallian. This species differs from *Actisecos* sp. 1 in having larger and much more convex colonies, larger zooids and ooecia, more densely and coarsely tuberculate peristomes, and larger frontal pores in raised conical processes. These characters make it appear more similar to *A. pulcher.*

Family Vicidae Gordon, 1988
Genus *Vix* Gordon, 1988

***Vix* sp.**
Pl. 36.

Figured material – NHMUK PI BZ 6953, BZ 6954, BZ 6955, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony erect, branching, branches bifurcating at an angle of about 80°, quadriserial (Fig. 1a, c). Autozooids distinct with a very thin, slightly raised wall, arranged in alternating longitudinal rows, semielliptical, elongate (mean L/W = 2.35). Frontal shield convex, distally raised, characterised by longitudinal ridges and furrows with small oval pores in between, evenly and widely spaced, about 30 μm apart (Fig. 1b, d). Orifice placed subterminally; primary orifice obliterated by sediment; secondary orifice semicircular, about 90 μm long by 115 μm wide, oral spine bases lacking. Median suboral avicularium placed on the proximal rim of the secondary orifice; rostrum always broken, giving the appearance of a pseudosinus in the secondary orifice (Fig. 1e). Ooecia not observed.

Measurements – ZL 615±46, 556-682 (3, 15); ZW 262±18, 235-290 (3, 15).

Remarks – A few branch fragments of *Vix* sp. have been found scattered in sediments of Burdigalian-Langhian age. The genus *Vix* is monotypic, comprising only the

type species, *V. vagans* (Thornely, 1912), described as secondary (reparative) jointed and basally rooted, from the Seychelles and Amirante Islands at 34-39 fathoms depth (about 62-71 m), and further recorded from east Africa and Zanzibar by Waters (1913). The Kalimantan fossil here identified as *Vix* sp. has similarly sized zooids to the type species, but the orifice is slightly more distally placed. However, the preservation of the fossil specimens prevents the observation of the primary orifice and avicularium rostrum, making further comparison difficult. The Kalimantan species represents the first fossil record for the genus, although a further, unpublished record of *Vix* is in the Miocene of Tanzania (B. Berning, research in progress).

Family Petraliidae Levinsen, 1909
Genus *Orbiculipora* Guha & Gopikrishna, 2005

***Orbiculipora* sp.**
Pl. 37.

Figured material – NHMUK PI BZ 6956, late Burdigalian, TF 126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Basal pore chambers absent. Autozooids large, distinct, with deep interzooidal furrows, a thin rim of calcification delineating a subhexagonal outline, longer than broad (men L/W = 1.31) (Fig. 1a, b). Frontal shield convex, smooth, perforated by numerous tiny pseudopores (Fig. 1c); marginal areolar pores indistinguishable from pseudopores. Orifice orbicular, slightly longer than wide, divided into a wide horseshoe-shaped anter and a smaller, shallow, bowl-shaped poster by two, blunt condyles (Fig. 1d). Peristome slightly raised. Avicularia and ooecia not observed.

Measurements – ZL 1400±122, 1248-1591 (2, 20); ZW 1069±61, 991-1160 (2, 20); OL 322±24, 287-366 (2, 20); OW 294±19, 264-324 (2, 20).

Remarks – A few colonies of *Orbiculipora* sp. have been found encrusting the undersides of platy corals from the late Burdigalian, often overgrown by encrusting foraminifera. The genus *Orbiculipora* is monospecific and was introduced for a Miocene species from Gujarat, India, with orifices of orbicular outline and pseudoporous frontal shields. The type species, *O. gigantea* Guha & Gopikrishna, 2005, has rare avicularia placed on the distal peristomial rim and very large, globose ooecia. All of the Kalimantan specimens lack avicularia and ooecia; however, colony size is too small to definitively preclude the presence of polymorphs in the Kalimantan species.

Family Microporellidae Hincks, 1879
Genus *Calloporina* Neviani, 1895

***Calloporina* sp.**
Pl. 38.

Figured material – NHMUK PI BZ 6958, Serravallian, TF 522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny poorly preserved; ancestrula outline oval, about 280 μm long by 200 μm wide; first generation of autozooids rounded triangular in outline, slightly smaller than later autozooids (Fig. 1a). Pore chamber windows visible at the colony growing edge along distolateral walls, small, rounded. Autozooids distinct with deep interzooidal furrows, oval or hexagonal, longer than broad (mean L/W = 1.31). Frontal shield slightly convex, rugose, imperforate centrally, with a single series of lateral areolar pores, numbering 4 to 6 along each margin, rounded or drop-shaped, and a few scattered circular pores between the orifice and the ascopore (Fig. 1b, d). Ascopore circular or longitudinally elliptical, mean diameter 50 μm, placed approximately at or slightly distally of mid-length, surrounded by a thin, raised rim (Fig. 1e). Orifice semicircular, slightly longer than wide, high-arched, proximal margin straight, surrounded by an uncertain number of oral spine bases, at least four, mean diameter 20 μm (Fig. 1e). Ooecium globose, hyperstomial, partially immersed in frontal shield of distal zooid, wider than long, smooth, with a narrow, about 35 μm wide, crescentic and pitted endooecium placed subterminally and surrounded by a thin raised rim (Fig. 1c). Avicularia long, slender, single or paired, if paired unequal in size, teardrop-shaped, originating laterally to ascopore, extending to proximolateral corner of orifice and oriented distally (Fig. 1e); rostrum elongate, triangular, raised, with acuminate tip reaching the lateral distal edge of the orifice; crossbar complete.

Measurements – ZL 546±56, 468-667 (1, 10); ZW 416±41, 357-475 (1, 10); OL 113±5, 109-118 (1, 5); OW 107±2, 105-109 (1, 5); OvL 231±19, 212-250 (1, 3); OvW 315±18, 300-335 (1, 3); AvL 184±30, 145-251 (1, 20).

Remarks – Two colonies of *Calloporina* sp. have been discovered on the undersides of very thin platy coral fragments from the Serravallian 'Coalindo Haulage Road 1' section. Unfortunately, the poor preservation of both colonies prevents the observation of diagnostic features such as, for example, the presence of condyles or denticulation on the proximal margin of the primary orifice, and the exact number of oral spine bases. Two Recent species of *Calloporina*, *C. sculpta* Canu & Bassler, 1929, and *C. sigillata* Canu & Bassler, 1929, originally reported from the Philippines, are known from a number of localities within the Indo-Pacific (Tilbrook, 2006). *C. sculpta* has similar sized autozooids, but differs from the Kalimantan fossil in having much longer avicularia distolaterally directed and a transversely oval ascopore, while in *Calloporina* sp. from Kalimantan the avicularia are distally directed and the ascopore is circular. *C. sigillata* is very similar to the Kalimantan species in the general appearance of autozooids with paired pointed avicularia, unequal in size, distally directed and touching the margins of the orifice, the circular ascopore and the ooecia with a narrow, widely arched, crescentic band of endooecium subterminally placed. However, the Kalimantan species has a single series of areolar pores and much smaller autozooids compared with *C. sigillata* (0.55 × 0.42 mm vs 0.95 × 0.65 mm).

Genus *Microporella* Hincks, 1877
Microporella aff. *browni* Harmelin, Ostrovsky, Cáceres-Chamizo & Sanner, 2011
Pl. 39.

aff. *Microporella browni* Harmelin, Ostrovsky, Cáceres-Chamizo & Sanner, 2011, p. 3, figs. 1A-G, 2A-E.

Figured material – NHMUK PI BZ 6957, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with raised lateral margins, quincuncially arranged, approximately pentagonal or oval, slightly longer than broad (mean L/W = 1.30). Frontal shield moderately convex, entirely covered by small rounded nodes with a few circular pseudopores intercalated between them (Fig. 1a, b); slit-like marginal areolar pores poorly visible. Primary orifice semicircular, broader than long, bearing six oral spine bases, about 10 μm in diameter, widely spaced (Fig. 1c); proximal and distal edges not visible because of sediment filling. Ascopore proximal to orifice at a distance equal to half of orifice length, surrounded by a thick, slightly raised rim; lumen C-shaped with a small, rounded, median process with denticles (Fig. 1c). Avicularium single, on the right or left, located close to the mediolateral margin of the autozooid, relatively distant from the ascopore (Fig. 1c); rostrum short, rounded triangular, truncated with channeled tip, distolaterally directed (Fig. 1b, c); crossbar complete. Ooecia 'personate', globular, broader than long, coarsely granular, with few small pores; no oral spine bases visible in ovicellate zooids (Fig. 1d).

Measurements – ZL 471±18, 437-482 (1, 10); ZW 361±26, 319-391 (1, 10); OL 77±9, 65-87 (1, 8); OW 104±4, 99-108 (1, 8); OvL 160±10, 150-170 (1, 3); OvW 206±17, 187-217 (1, 3); AvL 75±3, 72-79 (1, 10).

Remarks – Three species of *Microporella*, *M.* aff. *browni*, *M.* aff. *coronata* and *M.* sp. (see below), occur in the Miocene of East Kalimantan, but, unfortunately, are represented by a few poorly preserved colonies, all encrusting undersides of platy corals. This genus is one of the most distinctive and speciose Neogene cheilostomes, with the oldest occurrence dating from the Early Miocene of New Zealand and a widespread distribution at the present day (Taylor & Mawatari, 2005). However, species identification is difficult because it is often based on tiny morphological features of both non-mineralized parts, such as the avicularium mandibles, and skeletal characters, or the tiny teeth and condyles on the primary orifice (Harmelin *et al*., 2011), which are seldom completely preserved in fossil material. Furthermore, the limited availability of specimens from Kalimantan precludes evaluation of variability within a single species. The three species of *Microporella* from East Kalimantan are distinguished by: the size of the autozooids and orifice; aspects of the frontal shield; the number of oral spines (six, seven or eight); and the number and position of the avicularia. 'Ornamentation' (i.e., teeth and condyles) of the primary orifice, an attribute considered crucial for species differentiation, is obscured by sediment and all of the Kalimantan specimens have similarly sized ooecia, with a 'personate' structure.

Two species of *Microporella* have been described from the Miocene of Gujarat, India, *M. waghotensis* Guha & Gopikrishna, 2007, and *Microporella* sp., both differing from the Kalimantan species in having non-personate ooecia and oral spines absent or less numerous. Two Recent species of *Microporella* are commonly recorded from the Indonesian Archipelago, *M. orientalis* Harmer, 1957, and *M. harmeri* Hayward, 1988, both with personate ooecia. *M. orientalis* is characterized by having four oral spines and a saucer-like expansion of the ascopore rim, while *M. harmeri* has three oral spines and a large median process in the ascopore. Serravallian *Microporella* aff. *browni* is similar to the nominal species from the Recent in the size of the zooids, the possession of six oral spines, personate ooecia, and a single avicularium proximolateral to the ascopore and distolaterally directed. Pores on the frontal walls and ooecia are poorly visible due to preservational deficiencies. However, the most diagnostic feature of *M. browni* is the primary orifice, particularly the shape and distribution of the denticles on the distolateral edge, the corrugated proximal edge and the presence of two low condyles, characters which unfortunately cannot be observed in the fossil specimens. *M. browni* has been recorded at the present day from the southeast Mediterranean (Lebanon), Red Sea (Tadjoura) and Indian Ocean (Oman and Maldives). Colonies of this species show geographical variability in the number or oral spines (three to seven) and the exceptional presence of two avicularia. Zooidal size is also variable. The colonies from Kalimantan fall within the range of variability, their mean zooidal dimensions being more similar to those of the Oman specimens, while the ooecia are always smaller.

Microporella aff. *coronata* (Audouin, 1826)

Pl. 40.

aff. *Microporella coronata* Harmelin, Ostrovsky, Cáceres-Chamizo & Sanner, 2011, p. 9, fig. 4A-E.

Figured material – NHMUK PI BZ 6959, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, quincuncially arranged, hexagonal, slightly longer than wide (mean L/W = 1.32) (Fig. 1a). Frontal shield moderately convex, evenly covered by rounded nodules with very small pseudopores between (Fig. 1b); marginal areolar pores not visible. Primary orifice semicircular, broader than long, bearing seven oral spine bases, about 20 μm in diameter, widely spaced (Fig. 1c); proximal and distal edge not visible because of sediment infilling. Ascopore very large, located close to proximal edge of orifice, at a distance less than half orifice length, crescentic, surrounded by a thick, proximally raised rim (Fig. 1c); lumen and median process not visible. Avicularia paired, placed laterally to orifice and distally to ascopore (Fig. 1b); rostrum small, truncated, with channeled tip, directed distally or distolaterally at a small angle to axis of autozooid; crossbar complete (Fig. 1c). Ooecium 'personate', globular, broader than long, about 190 μm long by 265 μm broad, nodular and perforate (Fig. 1d); no oral spine bases visible on ovicellate zooids.

Measurements – ZL 521±42, 465-594 (1, 12); ZW 396±36, 353-455 (1, 12); OL 87±7, 76-94 (1, 10); OW 115±9, 102-127 (1, 10); AL 81±4, 77-89 (1, 6).

Remarks – Late Burdigalian *Microporella* aff. *coronata* represents the oldest record for this genus in the Kalimantan samples. This species is similar to *M. coronata* in the size of zooids, L/W proportion, nodular frontal shield with small pores, two latero-oral avicularia directed distally, ascopore rim proximally raised, and 'personate' ooecium. The number of oral spines in *M. coronata* varies from six to eight, but in most cases (59%) there are seven (Harmelin *et al.*, 2011), as in the Kalimantan species. *M. coronata* is characterized by a personate collar that surrounds the ascopore, a feature not clear in the fossil specimens. At the present day *M. coronata* has been recorded along the coast of Lebanon and from the Red Sea. Fossil records from the Mediterranean range from Miocene to Pleistocene but at least some may correspond to other species (Harmelin *et al.*, 2011).

Microporella sp.

Pl. 41.

Figured material – NHMUK PI BZ 6960, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, quincuncially arranged, hexagonal or oval, elongate (mean L/W = 1.68) (Fig. 1a). Frontal shield moderately convex, evenly perforated by numerous, relatively large, rounded, sunken pores that are absent only between the ascopore and the orifice (Fig. 1b, c). Primary orifice semicircular, broader than long, bearing eight oral spine bases, about 20 μm in diameter, closely spaced (Fig. 1d); proximal and distal edge not visible because of sediment infilling. Ascopore close to proximal edge of orifice, at a distance less than half orifice length, with C-shaped lumen and very small, rounded median process; ascopore rim raised proximally (Fig. 1d). Avicularium single, on the right or left, distolaterally placed approximately at the level of the ascopore, directed distolaterally or distally (Fig. 1d); rostrum and crossbar not visible. Ooecium 'personate', globular, broader than long, about 200 μm long by 265 μm wide, nodular and perforate (Fig. 1c); no oral spine bases visible on ovicellate zooids.

Measurements – ZL 619±40, 542-680 (1, 20); ZW 369±33, 330-423 (1, 20); OL 90±9, 79-105 (1, 20); OW 131±10, 118-149 (1, 20); AL 93±10, 85-111 (1, 10).

Remarks – *Microporella* sp. has been found in the section dated at the Burdigalian-Langhian boundary. It differs from the two previous species of *Microporella* described from Kalimantan in having much larger and more elongate zooids, a more porous and less nodular frontal shield, and a greater number of oral spine bases. In addition, although *Microporella* sp. shares with Serravallian *M.* aff. *browni* the presence of a single avicularium which is located laterally and directed distolaterally, this avicularium is at the level of the ascopore in the former species, but more proximally placed (below the level of the ascopore) in the latter. *M. donovani* Taylor & Foster, 1994, from the Plio-Pleistocene of Tobago is similar in the aspect of the frontal shield, but differs in having 4-5 oral spine bases vs. 8 of *M.* sp., and paired latero-oral avicularia.

Family Lacernidae Jullien, 1888
Genus *Arthropoma* Levinsen, 1909

Arthropoma renipora sp. nov.
Pl. 42.

Figured material – Holotype: NHMUK PI BZ 7002, late Burdigalian, TF126, '3D Reef', Bontang. Paratype: NHMUK PI BZ 6961, same details as holotype.

Etymology – Referring to the reniform pores on its frontal shield.

Diagnosis – Colony encrusting. Autozooids large, hexagonal. Frontal shield evenly perforated by reniform pores except for a median longitudinal area. Orifice semicircular with a deep sinus. Ooecia globular, imperforate.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids large, distinct, with deep interzooidal furrows, quincuncially arranged, hexagonal, slightly longer than broad (mean L/W = 1.35), size varying widely within the colony. Frontal shield convex, smooth, evenly perforated by numerous reniform pores, about 25 μm long by 10 μm wide, concave outwardly from long axis of zooid, a median longitudinal area (80-100 μm wide) is imperforate (Fig. 1a, d). Orifice small, semicircular, wider than long, proximal margin straight with two shallow lateral indentations, supporting two flat triangular condyles and a U-shaped, narrow, deep sinus, mean length 60 μm (Fig. 1d). Oral spine bases absent. Ooecia globular, smooth, imperforate, broader than long, mean length 220 μm and width 350 μm (Fig. 1b, c). Avicularia not observed.

Measurements – ZL 731±87, 538-822 (6, 60); ZW 561±75, 490-636 (6, 60); OL 125±21, 101-151 (6, 30); OW 157±20, 131-182 (6, 30).

Remarks – *Arthropoma renipora* sp. nov. is very abundant in the late Burdigalian, encrusting the undersides of platy corals. The Kalimantan species closely resembles the widespread *A. cecilii* (Audouin, 1826) known from Late Miocene to Recent. The main difference between these two species is the shape of the frontal pores, reniform in *A. renipora* sp. nov., rounded in *A. cecilii*. The presence of an imperforate median longitudinal area, variable in width, appears to be a common character (Harmer, 1957, p. 362), even though specimens of *A. cecilii*, from British waters (Hayward & Ryland, 1979) and the Kermadec Ridge of New Zealand (Gordon, 1984), for example, may exhibit an evenly perforated frontal wall. Canu & Bassler (1923) described *A. cornuta* from the Pliocene of Florida, USA, which differs from *A. renipora* sp. nov. and *A. cecilii* in the presence of a median umbo on a granular perforated frontal shield. A subspecies of *A. cecilii*, *A. cecilii donghaiensis* Lu, 1989, described from the Pliocene of China with an irregular and subnodular instead of encrusting colony morphology, had been probably misidentified and, based on the description and figures (Lu, 1989, pp. 41-42, pl. 5, figs. 1-5), seems likely belonging to the genus *Celleporina*.

Family Escharinidae Tilbrook, 2006
Genus *Bryopesanser* Tilbrook, 2006

Bryopesanser bragai sp. nov.
Pl. 43.

Figured material – Holotype: NHMUK PI BZ 6962, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Etymology – Named after Prof. Giampietro Braga, in recognition of his significant contribution to the study of bryozoans.

Diagnosis – Colony encrusting. Ancestrula tatiform, oval. Autozooids irregularly polygonal. Frontal shield evenly perforated with areolar pores at the proximal corners. Primary orifice with shallow condyles, deeply arched anter and drop-shaped sinus. Seven oral spine bases, six in ovicellate zooids. Peristome with a spire-like median umbo. Avicularia adventitious, paired. Ooecium cap-like, imperforate.

Description – Colony encrusting, multiserial, unilaminar, thick, small with on average 20 autozooids. Ancestrula tatiform, oval, with an undefined number of spine bases, generally partly or completely overgrown, budding a single rectangular zooid distally, similar to later autozooids but smaller, about 300 μm long by 200 μm wide (Fig. 1a, b). Second generation of autozooids 325-420 μm (mean L = 377 μm) long by 205-255 μm (mean W = 235 μm) wide, elongate (mean L/W = 1.60). Pore chamber windows visible at the colony growing edge, along lateral walls, oval, about 45 μm long by 20 μm wide (Fig. 1d). Autozooids distinct with raised lateral margins, irregularly arranged, rectangular, pentagonal or irregularly polygonal, longer than broad (mean L/W = 1.31). Frontal shield smooth, flat or slightly convex, evenly perforated with numerous minute rounded pseudopores (Fig. 1d); areolar pores sometimes visible at the proximal corners. Primary orifice slightly broader than long, anter deeply arched, proximal border slightly concave; condyles occupying the entire length of the proximal border, shallow, smooth, dipping medially; sinus drop-shaped, wider than long (Fig. 1c). Seven oral spine bases, evenly spaced (Fig. 1b); six in ovicellate zooids. Proximal peristome raised with a spire-like median umbo. Avicularia adventitious, paired, small, teardrop-shaped with rounded bended tip, originating laterally to most proximal pair of spines, distomedially directed, crossbar complete (Fig. 1c). Ooecium hyperstomial, small, cap-like, wider than long, smooth, imperforate (Fig. 1d).

Measurements – ZL 527±37, 468-579 (5, 50); ZW 401±27, 357-472 (5, 50); OL 100±7, 96-109 (5, 25); OW 108±7, 102-116 (5, 25); OvL 101±13, 79-108 (2, 5); OvW 140±8, 132-152 (2, 5); AL 78±7, 66-84 (5, 30).

Remarks – *Bryopesanser bragai* sp. nov. is a very common and abundant encruster on late Burdigalian and Serravallian platy and branching corals. Its colonies are usually small in size, with up to 20-25 autozooids, and precociously reproductive. This is the first formally described fossil example of the genus, although Berning *et al.* (2009) re-

ported *Bryopesanser* sp. as one of the most abundant encrusting bryozoans on lepidocyclinid foraminiferan tests from the Late Oligocene of Iran. Among Recent *Bryopesanser* species, three have been reported from Indonesia, *B. capitaneus* Tilbrook, 2006, *B. crebricollis* Tilbrook, 2012, and *B. puncturella* Tilbrook, 2012, while *B. latesco* Tilbrook, 2006, and *B. tonsillorum* Tilbrook, 2012, are Indo-Pacific in distribution (Tilbrook, 2012). Before, Tilbrook (2006) demonstrated the existence of a complex of similar species, they were all assigned to *Escharina pesanseris*, which was considered to be globally widespread in warm-temperate and tropical shallow waters, although Harmer (1957) did note subtle differences between specimens (Tilbrook, 2012). Morphological characters used to distinguish the different species of *Bryopesanser* are: primary orifice (shape of condyles, proximal orificial rim, sinus and peristome); size and position of avicularia; and frontal pore morphology. *Bryopesanser bragai* sp. nov. closely resembles *B. puncturella* in the smoothly calcified frontal shield with its multitude of minute pores, but differs in having smaller zooids, and both the orifice and the sinus are wider than long, whereas in *B. puncturella* they are longer than wide, and the peristome has a median mucro instead of being simply flared. In addition, *B. puncturella* usually forms large colonies consisting of about 100 zooids. *B. capitaneus* has much larger zooids and an ooecium with a raised process frontally; *B. crebricollis* has a pustulate frontal shield and no mucro on the peristome; *B. tonsillorum* has a sinus which is longer than wide, coarsely denticulate condyles and avicularia with serrated edges; and *B. latesco* has a straight proximal orificial rim, flared peristome slightly raised medially and avicularia originating laterally to the second pair of spines.

Bryopesanser sanfilippoae **sp. nov.**

Pl. 44.

Figured material – Holotype: NHMUK PI BZ 6963, Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.

Etymology – Named after Rossana Sanfilippo, palaeontologist at the University of Catania, Italy, for her research on Pleistocene and Recent invertebrates.

Diagnosis – Colony encrusting. Ancestrula tatiform, polygonal. Autozooids irregularly polygonal. Frontal shield granular, evenly perforated with teardrop-shaped areolar pores at the proximal corners. Primary orifice with deeply arched anter, minute condyles, and drop-shaped sinus. Number of oral spine bases probably seven; six in ovicellate zooids. Peristome absent. Avicularia adventitious, paired. Ooecium cap-like, imperforate.

Description – Colony encrusting, multiserial, unilaminar, thick, small, consisting on average of 15 autozooids. Ancestrula tatiform, polygonal, about 250 μm long by 200 μm wide, with an uncertain number of spine bases (Fig. 1b). A single, rounded hexagonal zooid budded proximally from the ancestrula, similar to later autozooids but smaller, about 300-325 μm long by 200-235 μm wide (Fig. 1b). Pore chamber windows visible in lateral walls at the colony growing edge, oval or circular, about 30 μm in diameter (Fig. 1a). Autozooids distinct with shallow interzooidal furrows, irregularly

arranged, rectangular, pentagonal or irregularly polygonal, longer than broad (mean L/W = 1.42). Frontal shield granular, convex, evenly perforated with numerous medium-sized, rounded pseudopores; areolar pores sometimes visible at the proximal corners, teardrop-shaped. Primary orifice almost as long as wide, anter deeply arched, proximal border straight; condyles occupying the entire length of the proximal border, shallow, minute; sinus drop-shaped, longer than wide (Fig. 1d). Number of oral spine bases in non-ovicellate zooids uncertain, probably seven; six in ovicellate zooids. Proximal peristome absent. Avicularia adventitious, paired, small, oval, originating lateral to most proximal pair of spines, distomedially directed, crossbar complete (Fig. 1c). Ooecium hyperstomial, very small, cap-like, wider than long, about 30 μm long by 80 μm wide, smooth, imperforate (Fig. 1c).

Measurements – ZL 442±43, 380-495 (5, 50); ZW 312±39, 244-377 (5, 50); OL 62±3, 60-64 (5, 25); OW 63±3, 61-65 (5, 25); AL 53±4, 48-55 (5, 30).

Remarks – *Bryopesanser sanfilippoae* sp. nov. is very common and abundant on the undersides of platy corals and branches in the Burdigalian-Langhian to Serravallian of Kalimantan. The lack of a proximal peristome is the most characteristic feature of this species. Autozooids of *B. hebelomaia* Tilbrook, 2012, known from Sri Lanka, also lack the peristome, except in brooding zooids. The two species further differ in the smaller size of the autozooids in the Kalimantan species, the size of the sinus, which is longer than wide in *B. sanfilippoae* sp. nov. and as long as wide in *B. hebelomaia,* and in the orientation of the avicularia, distomedially directed in the fossil and distally directed in the Recent species.

Superfamily Didymoselloidea Brown, 1952
Family Didymosellidae Brown, 1952
Genus *Tubiporella* Levinsen, 1909

***Tubiporella magnipora* sp. nov.**
Pl. 45.

Figured material – Holotype: NHMUK PI BZ 6964, late Burdigalian, TF126, '3D Reef', Bontang. Paratypes: NHMUK PI BZ 6965, BZ 6966, same details as holotype.

Etymology – Referring to the large areolar pores on its frontal shield.

Diagnosis – Colony erect. Branches triserial or quadriserial. Autozooids oval. Areolar pores of varying shape and size. Ascopore rimmed, placed at mid-length of the frontal shield. Peristome tall, imperforate, tuberculate. Secondary orifice semielliptical. One teardrop-shaped, adventitious avicularium per zooid. Ooecia cap-shaped.

Description – Colony erect, with flattened, foliaceous, narrow branches, about 1.5-2 mm wide, triserial or quadriserial, arising from a robust encrusting base. Abfrontal surface slightly convex and ridged. Autozooids arranged in longitudinal rows only on the frontal side of the branches, oval, longer than wide (mean L/W = 1.36). Frontal

shield pierced by large irregular areolar pores of varying shape and size, oval, circular drop-shaped, obscuring zooidal boundaries (Fig. 1b); ascopore rimmed, small, circular, 40-55 μm in diameter, placed at mid-length (Fig. 1c). Peristome tall, about 230 μm in length, imperforate, tuberculate, facing frontally or laterally (Fig. 1b, c). Secondary orifice semielliptical, wider than long (Fig. 1c); oral spine bases absent. A single, teardrop-shaped, adventitious avicularium per zooid, rarely oval, placed at ascopore level, varying in size, 85-180 μm long by 60-100 μm wide, medially or disto-medially directed, crossbar complete (Fig. 1a-d). Ooecia peristomial, small, about 125 μm long by 175 μm wide, cap-shaped, possessing the same nodular and pierced appearance as the frontal shield (Fig. 1e).

Measurements – ZL 604±45, 543-682 (5, 50); ZW 460±25, 421-488 (5, 50); OL 162±17, 142-187 (5, 25); OW 191±17, 165-207 (5, 25).

Remarks – Branch fragments of *Tubiporella magnipora* sp. nov. occur abundantly in silty sediments of late Burdigalian age, while a few encrusting bases have been found on the undersides of platy corals. The type species of the genus *Tubiporella*, *T. magnirostris* (MacGillivray, 1883), recorded from southern Australia, differs from the Kalimantan species in possessing paired adventitious avicularia with a much longer and more slender rostrum, smaller frontal areolar pores and shorter peristomes. *T. levinseni* Borg, 1940 (p. 420, pl. 1, figs. 5-8) from the Recent of the West Pacific is encrusting, with the frontal shield imperforate except for two rows of small, marginal pores, and an avicularium placed between the orifice and the ascopore. It may fit better in the genus *Reptadeonella*. The unique previous fossil record of *Tubiporella*, *T. bispinosa* Guha & Gopikrishna, 2007, from the Eocene of Gujarat, differs from the Miocene Indonesian species in having an encrusting colony-form and two prominent oral spine bases.

Superfamily Mamilloporoidea Canu & Bassler, 1927
Family Mamilloporidae Canu & Bassler, 1927
Genus *Anoteropora* Canu & Bassler, 1927

Anoteropora cf. *magnicapitata* Canu & Bassler, 1927
Pl. 46.

cf. *Anoteropora magnicapitata* Canu & Bassler, 1927, p. 10, fig. 11; Canu & Bassler, 1929, p. 476, pl. 65, figs. 1-4; Harmer, 1957, p. 888, pl. 59, figs. 18-21; Cook, 1966, p. 209; Cook & Chimonides, 1994, p. 53, figs. 1d, 2c-d.

Figured material – NHMUK PI BZ 6967, BZ 6968, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony lunulitiform (anchored by basal rhizoids in life), up to 5 mm in diameter, discoidal, low domal, underside concave, porous, with numerous small mounds and deep grooves outlining zooidal boundaries (Fig. 1a-c). Ancestrula central, similar to later autozooids but smaller and lacking avicularia, surrounded by about six periancestrular zooids slightly smaller in size than succeeding autozooids (Fig. 1b).

Autozooids distinct with raised margins, seemingly arranged in six radial rows radiating from the ancestrula with additional rows becoming intercalated between, zooidal outline hexagonal, broader than long (mean L/W = 0.86). Frontal shield slightly convex, granular, with occasional marginal pores (Fig 1d). Orifice almost central, rounded, as long as wide, with distinct lateral condyles downwardly directed, raised distally (Fig. 1d), shorter in ovicellate zooids (240 μm vs 190 μm) (Fig. 1e). Ooecium large, globular, minutely porous (Fig. 1e, f). Avicularia adventitious, single, located distally to each autozooid (Fig. 1d), absent in ovicellate zooids (Fig. 1e, f); rostrum raised, spearhead-shaped, medially or distomedially directed; crossbar complete.

Measurements – ZL 472±28, 435-519 (2, 40); ZW 552±49, 473-620 (2, 40); OL 242±12, 226-254 (2, 40); OW 243±13, 231-264 (2, 40); OvL 283±11, 275-291 (1, 2); OvW 410±33, 387-433 (1, 2); AL 230±10, 210-250 (2, 40).

Remarks – A few complete colonies and numerous fragments of *Anoteropora* cf. *magnicapitata* have been discovered in silty-muddy Serravallian sediments from Batu Putih along with free-living lunulitiform colonies of *Reussirella* sp. At the present day, four species of *Anoteropora* are known to occur in the Indian Ocean: *A. inarmata* Cook, 1965, *A. latirostris* Silén, 1947, *A. otophora* Cook & Chimonides, 1994, and *A. magnicapitata* Canu & Bassler, 1927. *A. inarmata* differs from the Kalimantan species in lacking avicularia, whereas *A. latirostris* and *A. otophora* differ in having, respectively, one and two avicularia lateral to the orifice on both non-ovicellate and ovicellate autozooids. In contrast, *A. magnicapitata* closely resembles the Serravallian species, both having the main diagnostic character of the nominal species, viz. the single, distally placed avicularium that is medially or distomedially directed and which is lacking in ovicellate zooid. This species is reported to have a wide Indo-West Pacific distribution, extending from the Torres Strait and the southern Philippines to the Red Sea, and along the coast of East Africa to southern Madagascar (Cook & Chimonides, 1994). Geographical differences among populations from different localities have been observed by Cook & Chimonides (1994), mainly concerning the size of the ooecia and orifices. Compared to Recent material from the Philippines and Bali, the Indonesian fossils have smaller zooids, with a different length/width ratio, and larger orifices in non-ovicellate autozooids, but smaller orifices in brooding zooids, smaller avicularia and less prominent ooecia, while the size of the avicularia and ooecia is similar to material from Zanzibar. A Miocene species of *Anoteropora, A. rajnathi* Tewari, Bhargava & Tandon, 1958, has been described from India. It differs from *A.* cf. *magnicapitata* in having six to eight large marginal pores, and smaller zooids, orifices and avicularia; ooecia have not been observed.

Superfamily Celleporoidea Johnston, 1838
Family Colatooeciidae Winston, 2005
Genus *Cigclisula* Canu & Bassler, 1927

Cigclisula aff. *ramparensis* Guha & Gopikrishna, 2007
Pl. 47.

aff. *Cigclisula ramparensis* Guha & Gopikrishna, 2007, p. 204, pl. 3, figs. 4-7.

Figured material – NHMUK PI BZ 6969, BZ 6970, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony erect with a small oval encrusting base, rigid, bilamellar, dichotomously branching. Branches relatively wide, with 5 to 10 zooidal series, cylindrical or flattened (Fig. 1a). Autozooids distinct with fine, shallow interzooidal furrows, arranged in alternating longitudinal rows, rhomboidal, longer than broad (mean L/W = 1.62). Frontal shield convex, perforated by 12-15 large circular pores, varying in size (Fig. 1c). Marginal areolar pores indistinguishable. Primary orifice deeply immersed, bell-shaped, longer than wide, arched distally with two sharp proximolateral condyles pointing downwards, and proximal margin with a very broad and shallow sinus (Fig. 1b). Secondary calcification affects the appearance of the orifice, with peristome thickening sometimes forming knots hiding the proximal orificial rim or even completely closing the orifice (Fig. 1d). Suboral avicularium (Fig. 1c, white arrow on the left), small, transverse, oval with complete crossbar. A variable number of similarly sized and shaped adventitious avicularia scattered on the frontal shields, deeply immersed (Fig. 1c, black arrows). Large interzooidal avicularia and ooecia not observed.

Measurements – ZL 606±42, 526-680 (5, 50); ZW 373±32, 310-422 (5, 50); OL 153±8, 141-164 (5, 30); OW 116±8, 107-126 (5, 30).

Remarks – *Cigclisula* aff. *ramparensis* is one of the most common species in the Serravallian 'Batu Putih 1' section. More than 1000 branch fragments have been found in the silty sediments. The abundance of available material allows the observation of character variation during ontogeny by secondary calcification. The Kalimantan species closely resembles Burdigalian *Cigclisula ramparensis* Guha & Gopikrishna, 2007, in the shape of the orifice, in having a transverse suboral avicularium, in the appearance of the frontal shield with scattered small avicularia and in the apparent lack of ooecia. It differs in having longer autozooids, a smaller orifice, and lacking interzooidal avicularia.

***Cigclisula* sp. 1**

Pl. 48.

Figured material – NHMUK PI BZ 6971, early Tortonian, TF508, Bontang.

Description – Colony erect, rigid, bilamellar. Branch fragments subcylindrical, flattened, 5-6 zooids in width (Fig. 1a). Autozooids distinct with a thin rim of calcification, arranged in alternating longitudinal rows, hexagonal or irregularly polygonal, longer than broad (mean L/W = 1.55). Frontal shield convex, perforated by a few large circular pores medially, and with drop-shaped areolar pores around lateral and proximal margins, separated by marked radial ridges (Fig. 1c). Primary orifice deeply immersed, subcircular, slightly longer than wide, about 160 μm long by 140 μm wide, arched distally with two lateral, rounded triangular condyles located at about mid-length, downwardly directed, and with a concave, wider proximal margin (Fig. 1d). Peristome forming two lateral tubercles/spines and one proximal umbo, acute, sharp, thick, inwardly directed,

hiding the orificial proximal rim (Fig. 1b, c). Avicularia suboral, small, about 60 μm long, oval, transverse, sloping, enclosed between the proximal orificial rim and the suboral umbo, with complete crossbar (Fig. 1b, d). A variable number of similarly sized and shaped adventitious avicularia scattered over the frontal shield (Fig. 1b, top right). Large interzooidal avicularia and ooecia not observed.

Measurements – ZL 614±33, 575-658 (1, 10); ZW 397±32, 337-429 (1, 10).

Remarks – A single fragment of *Cigclisula* sp. 1 has been found in sediments from the early Tortonian. Although well preserved, the scarcity of available material precludes species identification. However, it clearly differs from *Cigclisula* aff. *ramparensis* in having autozooids with more convex frontal shields, a peristome developing acute lateral spines, a suboral umbo hiding the primary orifice, a less elongate orifice, sloping suboral avicularia and marginal areolar pores distinct from the frontal pores. Similarities in the appearance of the frontal shield and in the shape of the orifice, including the presence of the suboral umbo, are apparent with Recent *C. areolata* (Kirkpatrick, 1890) recorded from the Torres Strait and the Great Barrier Reef.

***Cigclisula* sp. 2**

Pl. 49.

Figured material – NHMUK PI BZ 6972, BZ 6973, BZ 6974, early Tortonian, TF508, Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows and a thin rim of calcification, chaotically arranged, hexagonal or irregularly polygonal, slightly longer than broad (mean L/W = 1.17) (Fig. 1a, c, e). Frontal shield smooth or nodular, convex, medially perforated by 10-15 circular pseudopores medially (Fig. 1b, f), and with lateral areolar pores in drop-shaped depressions all around the zooecium, separated by low radial ridges (Fig. 1e). Primary orifice deeply immersed, longer than wide, two robust, triangular condyles located at about one-third of the length, proximally directed, separating a deeply arched anter from a shallow, larger, concave poster (Fig. 1b). Four to six perioral, massive, conical processes (Fig. 1a-c, e). Suboral avicularium, small, mean length 65 μm, oval, transverse, sloping, distolaterally directed, with complete crossbar (Fig. 1e, top left), sometimes absent. One or two additional, similarly sized, adventitious avicularia, oval or pear-shaped, marginal, generally located at the zooidal corners, transverse or randomly directed, with complete crossbar (Fig. 1a, b, d). Rare vicarious, spatulate avicularia, about 275 μm long, indenting the lateral margin of their sibling zooids (Fig. 1d); rostrum spoon-shaped, slightly narrowing (min W = 100 μm) immediately distally of the complete crossbar, then expanding distally (max W = 150 μm), with a straight tip and extensive palate (L = 125 μm), proximal opesia transversely crescent-shaped, distal opesia pear-shaped. Ooecia not observed.

Measurements – ZL 546±53, 441-624 (3, 20); ZW 467±54, 362-552 (3, 20); OL 173±4, 166-176 (3, 10); OW 145±6, 139-151 (3, 10).

Remarks – This species has been found only in the early Tortonian locality TF508, where two small encrusting fragments, detached from their substrate, and a small colony encrusting a very thin platy coral were collected. It differs from *Cigclisula* aff. *ramparensis* and *Cigclisula* sp. 1 in having an encrusting rather than an erect, bilamellar colony-form, and in its large spatulate avicularia. In addition, *Cigclisula* aff. *ramparensis* lacks perioral processes, while *Cigclisula* sp. 1 has only three, acute, thin spine-like peristomial tubercles rather than 4-6 massive processes, and the condyles are placed at mid-length in the orifice whereas they are more proximally placed in *Cigclisula* sp. 2.

Genus *Trematooecia* Osburn, 1940

Trematooecia sp.

Pl. 50.

Figured material – NHMUK PI BZ 6975, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, irregularly arranged, oval, erect and deep-bodied, longer than broad (mean L/W = 1.37) (Fig. 1a, b, e). Frontal shield smooth, convex, imperforate apart from a single row of oval areolar pores. Primary orifice deeply immersed, semicircular (Fig. 1e). Five perioral, massive, conical processes (Fig. 1a, b, e). Suboral avicularium absent. One or two adventitious avicularia, small, circular, mean diameter 60 μm, marginal, with complete crossbar (Fig. 1d). Large avicularia, about 400 μm long by 100 μm wide, probably vicarious; rostrum parallel-sided, with slightly spatulate tip, complete crossbar and extensive palate (L = 200 μm), proximal opesia transverse, oval, distal opesia high-arched, proximolaterally directed (Fig. 1c). Ooecium not observed.

Measurements – ZL 510±45, 447-592 (2, 12); ZW 372±23, 322-398 (2, 12); OL 146±11, 128-157 (2, 6); OW 126±16, 110-151 (2, 6).

Remarks – A few, small colonies of *Trematooecia* sp. are present on the undersides of platy corals from the late Burdigalian and Serravallian. Infilling sediment unfortunately prevents the observation of the primary orifice, and the poor preservation also makes difficult the recognition of ooecia, which in this genus can be completely immersed by secondary calcification and are visible mainly as a grid of small pores.

The Kalimantan species differs from the Recent Indo-Pacific *Trematooecia clivulata* Tilbrook, 2006, in the lack of pores in its frontal shield, and in the shape and size of the large avicularium, which is parallel-sided in the former but widely spatulate in *T. clivulata*. Other Neogene and Recent species do not show close similarity with the Kalimantan species, which must remain in open nomenclature because of the poor preservation of the colonies, especially of the orifices and ooecia.

Family Celleporidae Johnston, 1838
Genus *Buffonellaria* Canu & Bassler, 1917

Buffonellaria sagittaria sp. nov.
Pl. 51, fig. 1a-d.

Figured material – Holotype: NHMUK PI BZ 6976, late Burdigalian, TF126, '3D Reef', Bontang. Paratype: NHMUK PI BZ 6977, same details as holotype.

Etymology – Referring to the arrowhead-shaped rostra of its large frontal avicularia.

Diagnosis – Colony encrusting. Autozooids hexagonal. Frontal shield flat, generally smooth with sparse tubercles, imperforate. Primary orifice with rounded anter, small condyles and U-shaped sinus. Ooecium with narrow ectooecium and large, smooth, exposed endooecium. Suboral avicularia small, oval. Large frontal avicularia with arrowhead-shaped rostrum proximally directed and complete crossbar.

Description – Colony encrusting, multiserial, unilaminar or multilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with shallow interzooidal furrows, arranged quincuncially, hexagonal, longer than broad (mean L/W = 1.32) (Fig. 1a). Frontal shield slightly convex to flat, generally smooth except for some sparse, medioproximal, coarse, low tubercles, and imperforate except for a few small, reniform, areolar pores (Fig. 1d). Primary orifice on average as long as wide, length/width relationship variable, depressed (Fig. 1b); anter comprising two-thirds of a full circle, proximal margins short and slightly sloping, passing into a fairly broad and deep U-shaped sinus, occupying about one-fifth of total orifice length and half of its total width; condyles small, as long as proximal margins, rounded. Ooecium slightly wider than long, about 200 μm long by 230 μm wide, marginal band of ectooecium very narrow, exposed endooecium therefore large, with a smooth surface (Fig. 1c). Suboral avicularia small, oval, about 40 μm long, single, located proximolaterally of orifice, directed distolaterally, situated at the proximal end of a slightly raised and swollen cystid (Fig. 1b); crossbar not seen. Large frontal avicularia situated on lateral frontal shield, usually on the opposite side of the suboral avicularium, proximally directed, located on a swollen and smooth cystid gently sloping distally (Fig. 1c, d); rostrum arrowhead-shaped, narrowing distal to crossbar, long, thin, with a rounded tip; opesiae semicircular; crossbar complete.

Measurements – ZL 486±43, 426-553 (2, 30); ZW 368±30, 330-425 (2, 30); OL 100±8, 93-107 (2, 30); OW 99±5, 95-109 (2, 30); AL 134±1, 133-135 (2, 5).

Remarks – Two colonies of *Buffonellaria sagittaria* sp. nov., one of which is composed of two layers of zooids, have been discovered on the base of thin platy corals from the late Burdigalian. At the present day, the genus *Buffonellaria* occurs worldwide from the Arctic to the Antarctic, but individual species have restricted geographical distributions (Berning & Kuklinski, 2008). One fossil species of *Buffonellaria, B. cornuta* Guha & Gopikrishna, 2007, has been described from the Early Miocene (Aquitanian) of Gujarat;

two species, *B. holubicensis* Zágoršek, 2010, and *B. kuklinskii* Zágoršek, 2010, have been described from the Middle Miocene (Langhian) of the Czech Republic; and *B. entomostoma* (Reuss, 1847) has been reported from the Middle to Late Miocene of the Mediterranean region (see Berning, 2006, p. 114). *B. cornuta* differs from the Kalimantan species in having a large horn-shaped avicularium with the spatulate rostrum directed distolaterally; *B. holubicensis* and *B. kuklinskii* are both erect; and the species recorded as *B.* cf. *entomostoma* by Berning (2006) has large avicularia that are variably directed. With regard to general zooidal morphology and size, *Buffonellaria sagittaria* sp. nov. resembles Recent *B. ritae* Berning & Kuklinski, 2008, from Madeira. However, *B. ritae* has a much wider sinus, different proportions of ooecium length and width, and large avicularia with triangular instead of arrowhead-shaped rostra. A similar shaped avicularium is described for the Recent deep-sea species *B. nebulosa* (Jullien & Calvet, 1903) from the eastern Azores, but this species has much larger zooids, and small suboral avicularia that are generally paired and more distally placed than in the Kalimantan species.

Genus *Lagenipora* Hincks, 1877

Lagenipora sciutoi sp. nov.

Pl. 51, fig. 2a, b.

Figured material – Holotype: NHMUK PI BZ 6978, late Burdigalian, TF126, '3D Reef', Bontang.

Etymology – Named after Francesco Sciuto, palaeontologist at the University of Catania, Italy, for his research on Pleistocene and Recent invertebrates.

Diagnosis – Colony encrusting. Autozooids flask-shaped. Frontal shield imperforate, tuberculate. Peristome tubular. Avicularia absent. Ooecia with a frontal imperforate tabula.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Basal pore chambers oval, visible at the growing edge (Fig. 2b). Autozooids distinct with deep interzooidal furrows, quincuncially arranged, flask-shaped, longer than wide (mean L/W = 1.52) (Fig. 2a). Frontal shield slightly convex or flat, imperforate, granular, covered by numerous tubercles (Fig. 2b); areolar pores absent. Primary orifice hidden by a tall, tubular, smooth peristome with an elliptical secondary orifice (Fig. 2b). Peristomial and vicarious avicularia absent. Ooecia small, wider than long, distal to the peristome and with a frontal, flat, smooth, imperforate tabula (Fig. 2b).

Measurements – ZL 466±51, 394-559 (2, 25); ZW 306±37, 265-375 (2, 25); OvL 124±9, 116-133 (2, 6); OvW 177±7, 172-185 (2, 6).

Remarks – *Lagenipora sciutoi* sp. nov. forms small colonies on the base of late Burdigalian platy corals. It resembles the Recent *L. ferocissima* Gordon, 1984, from the Kermadec Ridge in having tuberculate frontal shields yet smooth peristomes, but it differs in

the lack of multibranched spinose processes on the tubercles and peristomial avicularia. *L. laevissima* Gordon, 1984, also lacks peristomial avicularia and has ooecia with flat, imperforate tabulae, but in this species the zooids are larger and linearly arranged, and the frontal shield is smooth. *Lagenipora sciutoi* sp. nov. differs from the type species, *L. lepralioides* (Norman, 1868) in lacking marginal areolar pores. *L. crenulata* Gordon, 1984, also lacks marginal pores and has similarly sized zooids, but the frontal shield is smooth and there is a pair of tiny peristomial avicularia as well as vicarious avicularia. The Miocene *L. chedopadiensis* Guha & Gopikrishna, 2007, from Gujarat, differs in having smooth or bulbous frontal shield fringed by areolar pores and a shorter peristome bearing an oval avicularium.

Genus *Predanophora* Tilbrook, 2006

Predanophora sp.

Pl. 52.

Figured material – NHMUK PI BZ 6979, Serravallian, TF59, 'Southern Hemisphere', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with shallow interzooidal furrows, arranged quincuncially, small, hexagonal, as long as wide (mean L/W = 1.01). Frontal shield slightly convex, evenly and densely tuberculate (Fig. 1b), with sparse, small, areolar pores. Primary orifice suborbicular, longer than wide, anter large, rounded, separated from the smaller, shallow poster by two faint condyles. Peristome widely flared, bearing avicularia on inner edge, single or paired, small, oval, proximolaterally placed, obliquely directed (Fig. 1c, d); crossbar not preserved. Ooecium globular, wider than long, resting on the frontal shield of the next distal autozooid; roof broken or incomplete (Fig. 1b, c).

Measurements – ZL 282±24, 254-331 (4, 40); ZW 278±24, 246-318 (4, 40); OL 90±5, 84-95 (4, 20); OW 73±3, 70-75 (4, 20); OvL 110±11, 99-128 (2, 16); OvW 130±12, 114-142 (2, 16); AL 52±4, 48-58 (2, 10).

Remarks – Although not abundant, *Predanophora* sp. has been found in a relatively large number of sections, from late Burdigalian to Serravallian. The genus was introduced by Tilbrook (2006) for *Drepanophora*-like species with a flared peristome and lacking a lyrula or oral denticles. Since then, two Recent species have been assigned to the genus, *P. longiuscula* (Harmer, 1957) and *P. ensenada* Tilbrook, 2006. The former species is recorded from the Bay of Suez at 13 m depth, the latter from the Solomon Islands. The Kalimantan species is distinguishable from both by its entire, minutely tuberculate frontal shield and its flared peristome with single or paired suboral avicularia.

Genus *Turbicellepora* Ryland, 1963

Turbicellepora aff. *canui* Guha & Gopikrishna, 2007

Pl. 53.

Figured material – NHMUK PI BZ 6980, Serravallian, TF76, 'Batu Putih 1', Samarinda.

Description – Colony multilaminar, forming nodular encrustations (Fig. 1a). Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, chaotically arranged, mostly erect and deep-bodied, longer than wide (mean L/W = 1.41) (Fig. 1c). Frontal shield thick, convex, smooth, with a few, large marginal pores. Primary orifice deeply immersed, centrally placed, subcircular, anter rounded, U-shaped poster by blunt condyles (Fig. 1b, c). Oral spines absent. Peristome high, bearing avicularia on the lateral margins, single or paired, oval or rhomboidal, small, 50 μm long by 40 μm wide, distally directed (Fig. 1b); crossbar complete. Large vicarious, spatulate avicularia occasionally occur; rostrum raised, tongue-shaped, randomly directed; palate smooth occupying about one-third of the total length; distal opesia large and oval (Fig. 1c, d); crossbar complete. Ooecia common, globular, suspended from the distal peristomial rim, recumbent on the frontal shield of the adjacent zooid, wider than long, smooth with numerous, large, round pores (Fig. 1b, d).

Measurements – ZL 459±35, 434-484 (2, 20); ZW 326±17, 315-338 (2, 20); OL 116±4, 114-119 (2, 8); OW 105±1, 104-105 (2, 8); OvL 162±7, 153-169 (2, 10); OvW 200±22, 171-210 (2, 10); AL 266±6, 261-270 (2, 10); AW 165±14, 155-175 (2, 10).

Remarks – *Turbicellepora* aff. *canui* commonly forms encrusting, mound-like colonies on branching coral or erect bryozoan fragments from the Serravallian section 'Batu Putih 1'. This species closely resembles *T. canui* Guha & Gopikrishna, 2007, from the Aquitanian of Gujarat, in orificial and ovicellular characters, and in having one or two small, peristomial avicularia and large, vicarious, spatulate avicularia. Although the size of the vicarious avicularia and ooecia is similar to the Indian species, the Kalimantan species has much smaller peristomial avicularia, about half size, but much larger autozooids (0.45 × 0.33 mm vs 0.18 × 0.16 mm). However, it should be noted that because the autozooids are generally upright in disposition, mostly developed in height instead of length, zooidal measurements have been taken at the periphery of the colony where autozooids show entirely their outlines. The large difference in zooidal size might therefore be due to a different way of taking measurements. The main difference between the Kalimantan and the nominal species is the palate length of spatulate avicularia, which extents to about 90% of total avicularium length in *T. canui* while it occupies only one-third of total length in *T.* aff. *canui*.

Family Hippoporidridae Vigneaux, 1949
Genus *Scorpiodinipora* Balavoine, 1959

Scorpiodinipora cf. *costulata* (Canu & Bassler, 1929)
Pl. 54.

cf. *Schizoporella costulata* Canu & Bassler, 1929, p. 317, pl. 36, fig. 10.
cf. *Scorpiodinipora costulata* Harmelin *et al*., 2012, p. 129, figs. 1-4.

Figured material – NHMUK PI BZ 6981, early Tortonian, TF508, Bontang.

Description – Colony encrusting, multiserial, unilaminar, large. Ancestrula small, oval, about 210 μm long by 150 μm wide, frontal shield not preserved, budding one proximal autozooid and one lateral autozooid seemingly deflected in a distal direction by a bump in the substrate, slightly larger than the ancestrula, smoother than later autozooids, budding a single or two other autozooids distally, increasing progressively in size, the colony becoming multiserial (Fig. 1c). Basal pore-chambers not seen. Autozooids distinct with deep interzooidal furrows, quincuncially arranged, hexagonal, slightly longer than wide (mean L/W = 1.29) (Fig. 1b). Frontal shield convex, mamillated, with circular areolar pores, widely spaced, generally two visible proximally and 2-3 laterally, totally hidden by calcification in some zooids, and 8-10 slightly pronounced radiating ribs between them (Fig. 1b). Orifice ovoidal, longer than wide, bearing distinct downwardly curved condyles placed a little lower than mid-length, with anter and poster similarly sized and rounded, lateral sides straight and parallel (Fig. 1b). Oral spines absent. Kenozooids variable in size and shape, irregularly polygonal, frontal shield the same as autozooids, but without an orifice, irregularly scattered within the colony (Fig. 1d). Ooecia, avicularia and nanozooids absent.

Measurements – ZL 357±16, 332-382 (1, 30); ZW 278±24, 235-304 (1, 30); OL 123±5, 116-132 (1, 30); OW 85±7, 73-95 (1, 30).

Remarks – A single well-preserved colony of *Scorpiodinipora* cf. *costulata* has been found encrusting a gastropod shell from the early Tortonian (Fig. 1a). At the present-day, *S. costulata* is distributed worldwide in shallow waters in tropical and sub-tropical seas, showing a marked preference for calcareous organic substrates, especially gastropod shells (Harmelin *et al*., 2012). Harmelin *et al.* (2012), examining specimens attributed to *S. costulata* from different geographical regions (Pacific Ocean, Philippines; Indian Ocean, Oman; Red Sea, Egypt; SE Mediterranean, Lebanon; SE Atlantic, Ghana; SW Atlantic, Brazil), observed the same general morphological features. Differences in the external aspect of the frontal shield, with more or less pronounced costae within and between colonies, were attributed to ontogeny and degree of calcification, whereas the variation in the mean size of the autozooids and orifices were explained by regional factors, such as local climatic conditions or specific traits of local populations (Harmelin *et al*., 2012). Another variation is in the number of daughter autozooids budded by the ancestrula in colonies from different localities, which can vary from two to four. Periancestrular zooids can be budded equally from the proximal and distal sides

of the ancestrula. Based on these observations, the Kalimantan specimen falls within the range of variability reported for the nominal species. The most similarly sized specimens are from Brazil. The nanozooids observed in colonies from Lebanon are absent in the fossil material; however, kenozooids without apertures are common.

This is the first documented unequivocal fossil record for *Scorpiodinipora*; Sendino & Taylor (2014) reported a questionable example from the Pliocene of Gran Canaria. Point mineralogical analysis made using Laser Raman Spectroscopy on the Kalimantan specimen showed the frontal shield to have an aragonitic composition, which may at least in part explain the previous absence of this genus from the fossil record.

Family Phidoloporidae Gabb & Horn, 1862
Genus *Lifuella* Gordon & d'Hondt, 1997

***?Lifuella* sp. 1**
Pl. 55, fig. 1a-c.

Figured material – NHMUK PI BZ 6982, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, multilaminar. Ancestrula and early astogeny not observed. Autozooids with shallow interzooidal furrows less distinct in some parts of the colony, quincuncially arranged, small, irregularly polygonal, as long as wide (mean L/W = 1.09) (Fig. 1a). Frontal shield convex, nodular, imperforate; areolar pores lacking or obscured by sediment. Orifice bell-shaped, almost equidimensional, with a broadly arcuate anter and slightly concave proximal rim; condyles not observed. Oral spine bases seven, 15-20 μm in diameter, closely spaced (Fig. 1b, c). Suboral umbo stout, partly overhanging the primary orifice (Fig. 1b). Adventitious avicularia latero-oral, oval, distolaterally directed, crossbar complete (Fig. 1b). Ooecia subimmersed, marginally covered by a layer of secondary calcification with the same nodular appearance as that of the frontal shield, central area smooth (Fig. 1b), wider than long, central roof usually broken.

Measurements – ZL 316±28, 273-352 (1, 10); ZW 290±31, 255-335 (1, 10); OL 86±6, 77-91 (1, 6); OW 91±8, 81-100 (1, 6); OvL 144±12, 127-161 (1, 5); OvW 166±9, 157-180 (1, 5); AL 66±8, 58-68 (1, 5); AW 43±2, 42-47 (1, 5).

Remarks – A single small, mound-like colony of ?*Lifuella* sp. 1 encrusts the base of a platy coral from the late Burdigalian. This colony is only tentatively assigned to *Lifuella* because its preservation prevents the observation of the inner rim of the primary orifice: the presence of denticulations differentiates *Fodinella* Tilbrook, Hayward & Gordon, 2001 from the otherwise similar *Lifuella*.

***?Lifuella* sp. 2**
Pl. 55, fig. 2a-c.

Figured material – NHMUK PI BZ 6983, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, multilaminar. Ancestrula and early astogeny not observed. Autozooids chaotically arranged, with a thin, raised rim, sometimes indistinct owing to preservation, irregularly polygonal, slightly longer than wide (mean L/W = 1.16) (Fig. 2a-c). Frontal shield convex, granular, imperforate (Fig. 2c); areolar pores absent. Orifice roughly bell-shaped, longer than wide. Oral spine bases numbering four, 10 μm in diameter, widely spaced (Fig. 2b, centre). Suboral umbo absent. Ooecia not observed. Adventitious avicularia suboral, teardrop-shaped, rostrum acute, medially directed, crossbar complete (Fig. 2c).

Measurements – ZL 411±26, 379-450 (1, 10); ZW 353±39, 283-392 (1, 10); OL 138±9, 128-149 (1, 5); OW 126±2, 122-129 (1, 5); AL 110±6, 103-118 (1, 5); AW 95±12, 79-103 (1, 5).

Remarks – This small, mound-like colony of ?*Lifuella* sp. 2 encrusts the base of a very thin platy coral of Serravallian age. It can be only tentatively assigned to *Lifuella* for the same reason mentioned above for ?*Lifuella* sp. 1. The two species differ in the size of zooids, in the shape, position and orientation of the avicularia, and in the number of oral spine bases.

Genus *Plesiocleidochasma* Soule, Soule & Chaney, 1991

Plesiocleidochasma cf. *laterale* (Harmer, 1957)

Pl. 56, fig. 1a, b.

cf. *Cleidochasma laterale* Harmer, 1957, p. 1044, pl. 71, figs. 9-11.
cf. *Plesiocleidochasma laterale* Soule, Soule & Chaney, 1991, p. 475, pl. 1, fig. 5; pl. 3, fig. 2. Tilbrook, 2006, p. 291, p. 291, pl. 64, figs. C-D.

Figured material – NHMUK PI BZ 6984, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar or multilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with shallow interzooidal furrows, quincuncially arranged, oval to polygonal, slightly longer than broad (mean L/W = 1.17). Frontal shield slightly convex, nodular, imperforate apart from a few, scattered, oval, areolar pores, usually visible only at distolateral corners (Fig. 1b). Orifice longer than broad, cleithridiate, surrounded by a thin, slightly raised rim; two small, rounded, lateral condyles separating a deeply arched, horseshoe-shaped anter from a shallow, smaller, bluntly arrow-shaped poster (Fig. 1b). Oral spine bases not observed. Ooecium globular, 163 μm long by 210 μm wide, observed only incomplete (Fig. 1b). Adventitious avicularia usually single, sometimes paired or absent, placed proximolaterally of orifice, varying in size (Fig. 1b); rostrum rounded triangular or lanceolate, directed distomedially, sometimes bent towards the distal rim of the orifice; opesia trifoliate; crossbar complete; smaller avicularia 125-156 μm, mean length 137 μm; larger avicularia length 200-283 μm, mean length 228 μm.

Measurements – ZL 519±36, 483-612 (1, 30); ZW 443±34, 389-518 (1, 30); OL 137±11, 122-158 (1, 30); OW 101±7, 87-114 (1, 30).

Remarks – A few extensive colonies of *Plesiocleidochasma* cf. *laterale* have been found encrusting late Burdigalian to Langhian platy corals. Some of these colonies show frontal budding and overgrowth by other bryozoan species such as *Puellina* spp. and *Arthropoma renipora* sp. nov. Unfortunately, none is fertile, apart from one colony in which only a broken ooecium has been observed (Fig. 1b). The Kalimantan fossil is similar to the Recent, widespread Indo-Pacific species *P. laterale* in the size and general appearance of the autozooids, and the shape and position of the avicularia which also vary in size. However, avicularia are distomedially directed in the Kalimantan species but distally directed in the nominal species, and the orifice is slightly smaller in the Kalimantan species. In addition, *P. laterale* is characterized by three distal oral spines which are not evident in the fossils, although the presence of oral spines in this genus seems often to be restricted to young zooids.

***Plesiocleidochasma* sp. 1**

Pl. 56, 2a-c.

Figured material – NHMUK PI BZ 6985, Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula with the same appearance as later autozooids but smaller, about 220 μm long by 150 μm wide, surrounded by six periancestrular autozooids, mean length 250 μm and width 200 μm (Fig. 2b). Autozooids distinct with shallow interzooidal furrows, quincuncially arranged, hexagonal, slightly longer than broad (mean L/W = 1.14). Frontal shield flat or slightly convex, nodular, sometimes developing a suboral umbo, imperforate apart from two, circular or oval, areolar pores, placed at variable distances apart, usually on the lateral corners corresponding to the maximum width of the zooids (Fig. 2b, c). Orifice longer than broad, cleithridiate, surrounded by a thin rim (Fig. 2c); two small, rounded, lateral condyles separating a deeply arched, horseshoe-shaped anter from a shallow, smaller, bluntly arrow-shaped poster. Oral spine bases numbering five (Fig. 2c). Ooecium globular, immersed on the frontal shield of the next distal autozooid, wider than long, roof usually incomplete (Fig. 2c). Avicularia absent.

Measurements – ZL 317±33, 268-374 (1, 30); ZW 278±21, 238-321 (1, 30); OL 107±6, 93-114 (1, 30); OW 77±3, 72-85 (1, 30); OvL 152±6, 143-160 (1, 5); OvW 212±10, 199-222 (1, 5).

Remarks – A single colony of *Plesiocleidochasma* sp. 1 has been found encrusting the underside of a very thin, platy coral fragment of Serravallian age. This species differs from *Plesiocleidochasma* cf. *laterale* (Harmer, 1957) in the absence of avicularia and in having conspicuous oral spine bases. The single colony found is small and dominated by astogenetically young zooids; distal oral spines are usually not prominent in species of *Plesiocleidochasma* except in young zooids. Although it differs from all fossil and Recent species previously described, the finding of only one colony without avicularia or complete ooecia does not favour the introduction of a new species.

***Plesiocleidochasma* sp. 2**
Pl. 56, fig. 3a-c.

Figured material – NHMUK PI BZ 6986, Messinian, TF 518, 'Kampung Narut', Sangkulirang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, quincuncially arranged, hexagonal, slightly longer than broad (mean L/W = 1.19). Frontal shield flat or taphonomically collapsed (Fig. 3a), nodular, imperforate apart from two, circular, areolar pores, usually placed at condyle level. Orifice longer than broad, cleithridiate (Fig. 3b); two small, rounded, lateral condyles separating a horseshoe-shaped anter from a shallow, smaller, wide, bluntly arrow-shaped poster. Oral spine bases not seen. Adventitious avicularia single or absent, small, placed proximolaterally to orifice (Fig. 3c); rostrum triangular with rounded tip, distolaterally directed; crossbar complete. Ooecia collapsed.

Measurements – ZL 498±35, 445-550 (1, 10); ZW 417±23, 389-449 (1, 10); OL 140±6, 133-144 (1, 5); OW 101±4, 97-106 (1, 5); OvL 230±17, 208-249 (1, 5); OvW 240±12, 223-251 (1, 5); AL 99±7, 93-113 (1, 6).

Remarks – A few colonies of *Plesiocleidochasma* sp. 2, usually with the frontal shields and ooecia collapsed, have been found encrusting the bases of Messinian platy corals. This species differs from the late Burdigalian material of *Plesiocleidochasma* cf. *laterale* in the shape and size of the adventitious avicularia, and from the Serravallian *Plesiocleidochasma* sp. 1 in having larger zooids, an adventitious frontal avicularium, a wider sinus and lacking oral spine bases. The most similar species seems to be Recent Indo-Pacific *Plesiocleidochasma porcellaniforme* (Soule, Soule & Chaney, 1991), which has a similarly nodular frontal shield and avicularia of comparable shape although with much more acute rostra. The Kalimantan species is left in open nomenclature owing to the poor preservation and the absence of ooecia in all available specimens.

Genus *Rhynchozoon* Hincks, 1895

***Rhynchozoon* sp.**
Pl. 57.

Figured material – NHMUK PI BZ 6987, early Tortonian, TF 508, Bontang.

Description – Colony encrusting, multiserial, multilaminar. Ancestrula and early astogeny not observed. Autozooids distinct with deep interzooidal furrows, irregularly arranged, oval to hexagonal, longer than wide (mean L/W = 1.39). Frontal shield convex, nodular, with a few, irregularly spaced, areolar pores varying in size from very small to very large (Fig. 1b, c). Primary orifice rounded, as wide as long, about 100 μm in diameter, stout, proximal border with wide, shallow, bowl-shaped sinus, occupying

about half its width, delimited by two lateral, rounded rectangular condyles (Fig. 1d); distal denticles widely spaced. Two oral spine bases, sometimes absent or covered by calcification of the distal zooid (Fig. 1b, c). Peristome including a tall, conical proximomedial process obscuring the orifice (Fig. 1b, c); unclear if it bears a suboral avicularium. Large frontal avicularia common, usually one per autozooid, placed on the proximal margin of the autozooid on a raised and swollen cystid, oval, proximolaterally directed (Fig. 1b, c); pivotal bar not preserved. Ooecia not observed.

Measurements – ZL 321±25, 295-378 (1, 10); ZW 231±10, 217-249 (1, 10); AL 104±10, 92-112 (1, 5).

Remarks – A single small colony of *Rhynchozoon* sp. encrusts an early Tortonian platy coral fragment. This species is characterised by an almost round orifice with shallow, bowl-shaped sinus, a tall, conical proximomedial process and a large, frontal, oval, raised avicularia. None of the Recent Indo-Pacific or Miocene European species of *Rhynchozoon* have this combination of characters. However, a new species is not introduced as only one small colony lacking ooecia is available for study.

Genus *Stephanollona* Duvergier, 1921

***Stephanollona* sp.**
Pl. 58.

Figured material – NHMUK PI BZ 6927, late Burdigalian, TF126, '3D Reef', Bontang.

Description – Colony encrusting, multiserial, unilaminar. Ancestrula and early astogeny not observed. Large, oval, pore chamber windows visible all around zooidal margins at the growing edge (Fig. 1b). Autozooids with deep interzooidal furrows, quincuncially arranged, oval, slightly longer than broad (mean L/W = 1.15). Frontal shield convex and smooth (Fig. 1b). Primary orifice longer than wide (including sinus), with round and denticulate anter separated from a shallow, bowl-shaped, narrower sinus by triangular condyles medially directed (Fig. 1c). Six oral spine bases (Fig. 1d). Adventitious avicularia paired, distolateral-oral, oval, distolaterally directed, with complete crossbar (Fig. 1b, d). Ooecia globular, wider than long, roof imcomplete or broken (Fig. 1a).

Measurements – ZL 387±25, 349-415 (2, 15); ZW 337±19, 320-378 (2, 15); OL 102±7, 92-108 (2, 10); OW 80±6, 71-85 (2, 10); OvL 144±10, 135-154 (1, 4); OvW 173±11, 156-181 (1, 4); AL 97±3, 94-101 (2, 8); AW 67±6, 59-73 (2, 8).

Remarks – A few poorly preserved colonies of *Stephanollona* sp. encrust the bases of platy corals from the late Burdigalian and Serravallian. Two species of *Stephanollona* have been described from the Cenozoic of France, *S. spinifera* Duvergier, 1921, and *S. dentata* Vigneaux, 1949. The Kalimantan species differs from *S. spinifera* in having shorter zooids and six oral spines rather than four or five, while it differs from *S. dentata* in having a primary orifice that is conspicuously longer than wide.

Genus *Triphyllozoon* Canu & Bassler, 1917

Triphyllozoon sp.

Pl. 59.

Figured material – NHMUK PI BZ 6988, BZ 6989, BZ 6990, BZ 6991, late Burdigalian, TF 126, '3D Reef', Bontang.

Description – Colony erect, rigid, dichotomously branching at angles of 30-40°; branches 0.30-0.40 mm wide, narrowest immediately after bifurcation, straight or slightly curved (Fig. 1a). Autozooids in 2 or 3 longitudinal rows, distinct, with raised sutures, flask-shaped, longer than broad (mean L/W = 1.67) (Fig. 1b). Frontal shield granular, flat or convex, with small, sparse, round, areolar pores along proximal and lateral margins, mean diameter 15 μm. Peristome tubular, relatively well developed; proximal rim with a deep and narrow, teardrop-shaped median sinus, and three stout denticles (Fig. 1c); oral spine bases numbering four in non-ovicellate zooids, widely and regularly spaced, comprising two smaller spine bases, 10-12 μm in diameter, placed distally and two larger spine bases, 18-20 μm in diameter, placed laterally; ovicellate zooids possessing only the two lateral spine bases (Fig. 1c-g). Secondary orifice elliptical, wider than long, about 100 μm wide by 45 μm long. Suboral avicularia of two kinds sometimes present: small, 50 μm long by 40 μm wide, oval, adjacent to sinus, with raised rostrum proximally or proximolaterally directed, and complete crossbar; or large, 100-120 μm long by 50 μm wide, with parallel-sided rostrum laterally directed, and complete crossbar (Fig. 1e). Frontal avicularia medium-sized, 70 μm long by 50 μm wide, spatulate, centrally placed, proximally or proximolaterally directed, with extensive palate, small oval opesia, and complete crossbar (Fig. 1b-d). Ooecia immersed in secondary calcification, appearing externally as a bulge, slightly wider than long, with a broad labellum and trilobate frontal fissure (Fig. 1f, g). Abfrontal surface granular, divided into irregularly polygonal sectors by vibices; within each sector sparse, small pores, and numerous, randomly directed, spatulate avicularia similar to those seen on the frontal shield (Fig. 1h, i).

Measurements – ZL 368±11, 358-385 (5, 50); ZW 221±16, 203-245 (5, 50); OvL 150±15, 140-160 (2, 6); OvW 160±16, 148-171 (2, 6).

Remarks – Hundreds of fragments of *Triphyllozoon* sp. have been found in silty sediments of late Burdigalian and Serravallian age in East Kalimantan. Genera of phidoloporids are distinguished by features of the ooecia and peristomes. In the Kalimantan specimens, the primary orifice is always hidden by infilling sediment and ooecia are often completely immersed by secondary calcification, making it difficult to observe diagnostic features. However, a preserved ooecium seems to show a trilobate fissure on its frontal (Fig. 1f, g), which allows the identification of this species as *Triphyllozoon*. Six Recent species of *Triphyllozoon* are known from the Indonesian Archipelago: *T. formosoides* Hayward, 2004, *T. indivisum* Harmer, 1934, *T. patulum* Harmer, 1934, *T. separatum* Harmer, 1934, *T. trifoliatum* Harmer, 1934, and *T. tuberculiferum* Harmer, 1934. All show a range of avicularian polymorphs that differ from those of the fossil species.

Although *T. patulum* has similar spatulate frontal avicularia, these are much larger and this species also differs in lacking suboral avicularia.

Phidoloporidae sp. 1
Pl. 60, fig. 1a-e.

Figured material – NHMUK PI BZ 6992, BZ 6993, late Burdigalian, TF 126, '3D Reef', Bontang.

Description – Colony erect, rigid, ?fenestrate, dichotomously branching at an angle of 40-50°; branches 0.35-0.55 mm wide, narrowest after bifurcation, curved (Fig. 1a, c). Autozooids in three longitudinal rows, distinct, with raised sutures, rectangular to irregularly polygonal, longer than broad (mean L/W = 1.43) (Fig. 1b). Frontal shield smooth with gentle irregularities, and sparse, round, areolar pores along proximal and lateral margins, mean diameter 25 μm. Secondary orifice subcircular, 85-100 μm in diameter; proximal rim undulose, with a transversely set, medially placed avicularium, small, oval, about 30 μm long by 23 μm wide, crossbar complete (Fig. 1b). Oral spines absent. Frontal avicularia of two kinds: medium-sized, 80-100 μm long by 30 μm wide, oval, medioproximally placed and medially directed; and large, 180-250 μm long by 55 μm wide, with raised, narrow, triangular or spoon-shaped rostrum and channeled tip, placed underneath the orifice, proximolaterally directed; both types with extensive palate, small oval opesia, and complete crossbar (Fig. 1b). Ooecia not observed. Abfrontal surface smooth, divided into irregular sectors by vibices; within each sector sparse, small pores and numerous, randomly directed avicularia of three kinds: (1) small and oval similar to suboral avicularia; (2) medium-sized elongate oval or triangular similar to those seen on the frontal; and (3) very long (L = 300-400 μm), narrow (W = 60-80 μm) avicularia with slightly spatulate rostrum, extensive palate, triangular opesia, and complete crossbar (Fig. 1d, e).

Measurements – ZL 359±22, 323-383 (5, 50); ZW 251±23, 218-271 (5, 50).

Remarks – Phidoloporidae sp. 1 is very abundant in late Burdigalian silty sediments. However, ooecia have not been observed in any of the specimens, probably because of the poor preservation and secondary calcification. Characters of the peristome and primary orifice are also poorly preserved or hidden by sediment. The absence of these key morphological features prevents an unambiguous identification to genus level.

Phidoloporidae sp. 2
Pl. 60, fig. 2a-d.

Figured material – NHMUK PI BZ 6994, BZ 6995, late Burdigalian, TF 126, '3D Reef', Bontang.

Description – Colony erect, rigid, dichotomously branching at an angle of 60°; branches 0.28-0.36 mm wide, narrowest after bifurcation, straight or slightly curved (Fig. 2a, c). Autozooids in one or two longitudinal rows, distinct, with raised sutures,

flask-shaped, longer than broad (mean L/W = 1.54). Frontal shield smooth with single or paired, small, round, areolar pores proximally, mean diameter 17 μm (Fig. 2b). Peristomial orifices elliptical, 100 μm long by 60-70 μm wide; proximal rim undulose, with a small U-shaped sinus medially (Fig. 2b). Oral spines absent. Frontal avicularia absent. Ooecia not observed. Abfrontal surface granular, divided into irregular sectors by vibices; within each sector sparse, small pores and numerous large avicularia, varying in size, 160-230 μm long by 50-70 μm wide, rostrum triangular with acute distal tip, proximally or proximolaterally directed, extensive palate, pear-shaped opesia, crossbar lacking (Fig. 2c, d).

Measurements – ZL 392±14, 374-413 (5, 25); ZW 255±13, 240-266 (5, 25).

Remarks – Phidoloporidae sp. 2 is very abundant in late Burdigalian silty sediments, along with *Triphyllozoon* sp. and Phidoloporidae sp. 1. It differs from these two phidoloporids in the shape of the peristomial sinus, in lacking oral and frontal avicularia, and in the shape of abfrontal avicularia. The absence of ooecia precludes a generic identification.

Phidoloporidae sp. 3
Pl. 61, fig. 1a-e.

Figured material – NHMUK PI BZ 6996, BZ 6997, Serravallian, TF 76, 'Batu Putih 1', Samarinda.

Description – Colony erect, rigid, fenestrate; fenestrulae oval (0.9-1.4 × 0.4-0.7 mm), consisting of two to four alternating, longitudinal series of autozooids (Fig. 1a). Autozooids distinct, with raised sutures, rectangular, longer than broad (mean L/W = 1.97). Frontal shield smooth; one or two areolar pores proximally. Peristomial orifices subcircular, averaging 100 μm in diameter. Peristome thin, scarcely raised, proximal rim smooth with a small teardrop-shaped sinus medially (Fig. 1c). Uncertain number of oral spine bases in non-ovicellate autozooids; two lateral oral spine bases in ovicellate zooids. Ooecia longer than wide, 190 μm long by 170 μm wide, with a short, longitudinal suture (Fig. 1b, c). Frontal adventitious avicularia absent; large vicarious avicularia rare, placed on the edges of the fenestrulae, rostrum triangular with truncated tip, 200 μm long by 70 μm wide, proximolaterally directed (Fig. 1d). Abfrontal surface nodular, divided into irregular sectors by vibices (Fig. 1e); avicularia not observed.

Measurements – ZL 454±25, 422-480 (5, 25); ZW 230±14, 215-250 (5, 25).

Remarks – Phidoloporidae sp. 3 is very abundant in the Serravallian silty sediments of 'Batu Putih 1', along with several different erect species such as *Adeonellopsis* sp. 2, *Cigclisula* aff. *ramparensis*, and *Sendinopora prima* sp. nov. (see below) among others. This species is distinguished from all other erect phidoloporid species described here mainly in its ooecia with a short, longitudinal suture, the presence of vicarious avicularia and lack of frontal and suboral adventitious avicularia. Similar ooecia characterise species of both *Reteporella* and *Reteporellina*. An additional feature, useful in discrimi-

nating between the two genera, is the peristome, which varies from widely open to deep with a medioproximal sinus in *Reteporella*, to deep with a flared proximal rim developed into rounded crenulations, bearing a narrow medioproximal sinus in *Reteporellina*. Unfortunately, specimens from Kalimantan, even though abundant, are poorly preserved, and with peristomes broken and abraded.

Summary

The Miocene bryozoans described from East Kalimantan in this study, including the first part of the present monograph (Di Martino & Taylor, 2014), number 123 species and comprise 15 cyclostomes, 36 anascan-grade and 72 ascophoran-grade cheilostomes.

The faunas include 33 new species (26%), two of which, the cribrimorph *Antoniettella exigua* Di Martino & Taylor, 2012a, and the anascan *Setosinella perfluxa* Di Martino & Taylor, 2012b, were introduced in earlier papers. Of the remaining 31 new species described, two are cyclostomes and belong to the genera *Microeciella* and *Pseudidmonea*, nine are anascans belonging to the genera *Cranosina* (1 species), *Parellisina* (1), *Vincularia* (4), ?*Gontarella* (1) and *Canda* (2), and 20 species are ascophorans classified in the genera ?*Filaguria* (1), *Puellina* (1), *Caberoides* (1), *Trypostega* (1), *Oviexechonella* gen. nov. (1), *Reptadeonella* (2), ?*Hippomenella* (2), *Margaretta* (1), *Hippopodina* (1), *Saevitella* (1), *Gigantopora* (1), *Arthropoma* (1), *Bryopesanser* (2), *Tubiporella* (1), *Buffonellaria* (1), *Lagenipora* (1), and *Sendinopora* gen. nov. (1).

Twenty-six taxa (22%) have been identified provisionally to species level. Among them, 20 species (16%) show Recent Indo-Pacific affinities; two (2%), *Scorpiodinipora* cf. *costulata* and *Hippopodina* cf. *pulcherrima*, show similarities to Recent species recorded circumtropically; and three species (3%) are closely related to previously known taxa from the fossil record: *Adeonellopsis* aff. *obliqua* from the Cenozoic of Australia, and *Cigclisula* aff. *ramparensis* and *Turbicellepora* aff. *canui* from the Early Miocene of India.

The remaining 65 species (53%) have been identified only at genus- or family- levels owing to deficient preservation and/or scarcity of available material. Of the 61 species (50%) identified at genus level, twelve (9%) are assigned to a genus only tentatively, while one ('*Berenicea*' sp.) is a *nomen dubium* used here as a form genus. The most diverse genus is *Vincularia* with five species, followed by *Disporella* with four species, and *Puellina*, *Adeonellopsis*, *Stylopoma*, *Hippopodina*, *Microporella* and *Cigclisula* with three species each. Four taxa (3%) have been identified only to family level, one belonging to Pyrisinellidae, and three erect, fenestrate species belonging to Phidoloporidae.

The 123 species from East Kalimantan belong to 78 genera, including three newly erected, *Antoniettella*, *Oviexechonella* and *Sendinopora*, within 48 families. Of these 48 families, most contain only one (20 families), two (12 families), three (1 family), four (8 families) or five species (5 families). Two families – Calloporidae and Phidoloporidae – contain six and eleven species in four and six genera, respectively. Apart from these two families, the most diverse are Smittinidae, Hippopodinidae and Celleporidae with 4 genera each.

The majority of the bryozoan species (71%) from the Miocene of East Kalimantan are encrusting, typically with two-dimensional colonies; 25% of species are erect, with the majority of these articulated and flexible; and 4% of the species are free-living.

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References

Audouin, J.V. 1826. Explication sommaire des planches de polypes de l'Egypte et de la Syrie, publiées par Jules-Cesar Savigny. *In*: Audouin, J.V. (Ed.), *Description de l'Egypte, ou recueil des observations et des recherches qui ont été faites en Egypte pendant l'expédition de l'armée française ... Histoire naturelle*. Imprimerie Impériale, Paris: 339 pp.

Balavoine, P. 1959. Bryozoaires. *Mission Robert Ph. Dollfus en Égypte (Décembre 1927-Mars 1929). S.S. "Al Sayad". Résultats Scientifiques,* 3e partie, **34**: 257-280.

Bassler, R.S. 1935. Bryozoa. Generum et Genotyporum. Index et Bibliographica. *Fossilium Catalogus I. Animalia*. W. Junk, 's-Gravenhage: 229 pp.

Bassler, R.S. 1936. Nomenclatorial notes on fossil and Recent Bryozoa. *Journal of the Washington Academy of Science,* **26**: 156-162.

Berning, B. 2006. The cheilostome bryozoan fauna from the Late Miocene of Niebla (Guadalquivir Basin, SW Spain): environmental and biogeographic implications. *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg,* **90**: 7-156.

Berning, B. 2013. New and little-known Cheilostomata (Bryozoa, Gymnolaemata) from the NE Atlantic. *European Journal of Taxonomy*, **44**: 1-25.

Berning, B. & Kukliński, P. 2008. North-east Atlantic and Mediterranean species of the genus *Buffonellaria* (Bryozoa, Cheilostomata): implications for biodiversity and biogeography. *Zoological Journal of the Linnean Society,* **152**: 537-566.

Berning, B., Reuter, M., Piller, W.E., Harzhauser, M. & Kroh, A. 2009. Larger foraminifera as a substratum for encrusting bryozoans (Late Oligocene, Tethyan Seaway, Iran). *Facies*, **55**: 227-241.

Bishop, J.D.D. & Househam, B.C. 1987. *Puellina* (Bryozoa; Cheilostomatida; Cribrilinidae) from British and adjacent waters. *Bulletin of the British Museum (Natural History), Zoology*, **53**: 1-63.

Bobies, C.A. 1956. Bryozoenstudien. I. Die Bryozoenfauna der tortonen Strandbildungen von Kalkslburg bei Wien. *Jahrbuch der Geologischen Bundesanstalt, Wien,* **99**: 225-258.

Borg, F. 1940. On the genus *Tubiporella* and on a new boring bryozoan. *Zoologiska Bidrag från Uppsala,* **18**: 415-438.

Branch, M.L. & Hayward, P.J. 2005. New species of cheilostomatous Bryozoa from subantarctic Marion and Prince Edward Islands. *Journal of Natural History,* **39**: 2671-2704.

Brown, D.A. 1952. *The Tertiary Cheilostomatous Polyzoa of New Zealand*. Trustees of the British Museum (Natural History), London: 405 pp.

Busk, G. 1852. An account of the Polyzoa, and sertularian Zoophytes, collected in the voyage of the *Rattlesnake*, on the coasts of Australia and the Louisiade Archipelago, &c. *In*: MacGillivray, J., *Narrative of the Voyage of the H.M.S. Rattlesnake,…during the years 1846-1850, Volume 1*. Boone, London: 343-402.

Busk, G. 1854. *Catalogue of marine Polyzoa in the collection of the British Museum, II. Cheilostomata (part)*. Trustees of the British Museum, London: 120 pp.

Busk, G. 1859. *A Monograph of the Fossil Polyzoa of the Crag.* Palaeontographical Society, London: 136 pp.

Busk, G. 1884. Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876. Part 1. The Cheilostomata. *Report on the Scientific Results of the Voyage of the H.M.S. "Challenger", Zoology*, **10**: 1-216.

Calvet, L. 1909. *Bryozoaires*. Expedition antarctique Française (1903-1905). Sciences naturelle, documents scientifiques: 49 pp.

Canu, F. 1904. Étude de bryozoaires tertiaries recueillis en 1885 et 1886 par M.Ph. Thomas dans la region sud de la Tunisie. *Exploration scientifique de la Tunisie 1904*, 1-37.

Canu, F. 1908. Les Bryozoaires des terrains tertiaires des environs de Paris. *Annales de Paléontologie*, **3**: 61-104.

Canu, F. & Bassler, R.S. 1917. A synopsis of American Early Tertiary cheilostome Bryozoa. *Bulletin of the United States National Museum*, **96**: 1-87.

Canu, F. & Bassler, R.S. 1920. North American Early Tertiary Bryozoa. *Bulletin of the United States National Museum*, **106**: 1-879.

Canu, F. & Bassler, R.S. 1923. North American later Tertiary and Quaternary Bryozoa. *Bulletin of the United States National Museum*, **125**: 1-302.

Canu, F. & Bassler, R.S. 1927. Classification of the cheilostomatous Bryozoa. *Proceedings of the United States National Museum*, **69** (14): 1-42.

Canu, F. & Bassler, R.S. 1928. Fossil and Recent Bryozoa of the Gulf of Mexico region. *Proceedings of the United States National Museum*, **72**: 1-199.

Canu, F. & Bassler, R.S. 1929. Bryozoa of the Philippine region. *Bulletin of the United States National Museum*, **100**: 1-685.

Canu, F. & Bassler, R.S. 1930. The Bryozoa of the Galapagos Islands. *Proceedings of the United States National Museum*, **76**: 1-78.

Canu, F. & Bassler, R. S. 1935. New species of Tertiary cheilostome Bryozoa from Victoria, Australia. *Smithsonian Miscellaneous Collections*, **93**: 1-54.

Cook, P.L. 1965. Notes on the Cupuladriidae (Polyzoa, Anasca). *Bulletin of the British Museum (Natural History), Zoology*, **13**: 151-187.

Cook, P.L. 1966. Some 'sand fauna' Polyzoa (Bryozoa) from Eastern Africa and the northern Indian Ocean. *Cahiers de Biologie Marine*, **7**: 207-223.

Cook, P.L. 1977. The genus *Tremogasterina* Canu (Bryozoa, Cheilostomata). *Bulletin of the British Museum (Natural History), Zoology*, **35**: 103-165.

Cook, P.L. 1985. Bryozoa from Ghana. A preliminary survey. *Annales Musée de l'Afrique centrale, Sciences Zoologiques, Tervuren*, **238**: 1-315.

Cook, P.L. & Bock, P.E. 2004. *Exechonella* (Exechonellidae: Bryozoa, Cheilostomata) from the Recent and Miocene of southern Australia. *Proceedings of the Royal Society of Victoria*, **116**: 265-282.

Cook, P.L. & Chimonides, P.J. 1994. Notes on the family Cupuladriidae (Bryozoa), and on *Cupuladria remota* sp. n. from the Marquesas Islands. *Zoologica Scripta*, **23**: 251-268.

David, L. 1965. Bryozoaires du Néogène du Bassin du Rhône. Gisements vindoboniens de la région lyonnaise. *Travaux des Laboratoires de Géologie de la Faculté des Sciences de Lyon*, **12**: 33-86.

Dick, M.H., Tilbrook, K.J. & Mawatari, S.F. 2006. Diversity and taxonomy of rocky-intertidal Bryozoa on the Island of Hawaii, USA. *Journal of Natural History*, **40**: 2197-2258.

Di Martino, E. & Taylor, P.D. 2012a. Systematics and life history of *Antoniettella exigua*, a new genus and species of cribrimorph bryozoan from the Miocene of East Kalimantan (Indonesia). *Bollettino della Società Paleontologica Italiana*, **51**: 99-108.

Di Martino, E. & Taylor, P.D. 2012b. Pyrisinellidae, a new family of anascan cheilostome bryozoans. *Zootaxa*, **3534**: 1-20.

Di Martino, E. & Taylor, P.D. 2014. Miocene Bryozoa from East Kalimantan, Indonesia. Part I: Cyclostomata and Cheilostomata 'Anasca'. *Scripta Geologica,* **146**: 17-126.

Duvergier, J. 1921. Note sur les Bryozoaires du Néogène de l'Aquitaine. *Actes de la Société Linnéenne, Bordeaux,* **72**: 145-182.

Duvergier, J. 1924. Deuxième note sur les Bryozoaires du Néogène de l'Aquitaine. *Actes de la Société Linnéenne, Bordeaux*, **75**: 145-190.

El Hajjaji, K. 1987. Bryozoaires nouveaux du Messinien de Mellilla (Maroc nord-oriental). *Geobios*, **20**: 687-694.

Fransen, C.H.J.M. 1986. Caribbean Bryozoa: Anasca and Ascophora Imperfecta of the inner bays of Curaçao and Bonaire. *Studies on the Fauna of Curaçao and other Caribbean Islands,* **68**: 1-119.

Gabb, W.M. & Horn, G.H. 1862. The fossil Polyzoa of the Secondary and Tertiary Formations of North America. *Journal of the Academy of Natural Sciences of Philadelphia,* **5**: 111-179.

Gordon, D.P. 1984. The marine fauna of New Zealand: Bryozoa Gymnolaemata from the Kermadec Ridge. *New Zealand Oceanographic Institute Memoir*, **91**: 1-198.

Gordon, D.P. 1988. The bryozoan families Sclerodomidae, Bifaxariidae, and Urceoliporidae and a novel type of frontal wall. *New Zealand Journal of Zoology*, **15**: 249-290.

Gordon, D.P. & Braga, G. 1994. Bryozoa: Living and fossil species of the catenicellid subfamilies Ditaxiporinae Stach and Vasignyellidae nov. *Mémoires du Muséum National d'Histoire Naturelle*, **161**: 55-85.

Gordon, D.P. & d'Hondt, J.-L. 1997. Bryozoa: Lepraliomorpha and other Ascophorina from New Caledonian waters. *Mémoires du Muséum National d'Histoire Naturelle,* **176**: 9-124.

Gray, J.E. 1843. Additional radiated animals and Annelides. *Travels in New Zealand: with contributions to the geography, geology, botany, and natural history of that country*, **2**: 292-295.

Guha, A.K. & Gopikrishna, K. 2005. New petraliid cheilostome bryozoan taxa from Aquitanian of western Kachchh, Gujarat, India. *Neues Jahrbuch für Geologie und Paläontologie Monatshefte,* **11**: 694-704.

Guha, A.K. & Gopikrishna, K. 2007. Some fossil ascophoran bryozoan taxa from Tertiary sequences of western Kachchh, Gujarat. *Journal of the Palaeontological Society of India*, **52**: 195-222.

Harmelin, J.-G., Ostrovsky, A.N., Cáceres-Chamizo, J. & Sanner, J. 2011. Bryodiversity in the tropics: taxonomy of *Microporella* species (Bryozoa, Cheilostomata) with personate maternal zooids from Indian Ocean, Red Sea and southeast Mediterranean. *Zootaxa*, **2798**: 1-30.

Harmelin, J.-G., Vieira, L.M., Ostrovsky, A.N., Cáceres-Chamizo, J. P. & Sanner, J. 2012. *Scorpiodinipora costulata* (Canu & Bassler, 1929) (Bryozoa, Cheilostomata), a taxonomic and biogeographic dilemma: complex of cryptic species or human-mediated cosmopolitan colonizer? *Zoosystema*, **34**: 123-138.

Harmer, S.F. 1934. The Polyzoa of the Siboga Expedition. Part 3. Cheilostomata Ascophora, I. Family Reteporidae. *Siboga Expedition Reports,* **28c**: 502-640.

Harmer, S.F. 1957. The Polyzoa of the Siboga Expedition, Part 4. Cheilostomata Ascophora II. *Siboga Expedition Reports,* **28d**: 641-1147.

Hayward, P.J. 1988. Mauritian cheilostome Bryozoa. *Journal of Zoology, London*, **215**: 269-356.

Hayward, P.J. 2004. Taxonomic studies on some Indo-West Pacific Phidoloporidae (Bryozoa: Cheilostomata). *Systematics and Biodiversity,* **1**: 305-326.

Hayward, P.J. & Cook, P.L. 1983. The South African Museum's Meiring Naude Cruises. Part 13, Bryozoa II. *Annals of the South African Museum*, **91**: 1-161.

Hayward, P. J. & Ryland, J. S. 1979. *British Ascophoran Bryozoans*. *In*: Kermack, D.M. & Barnes, R.S.K. (Eds.), Synopses of the British Fauna. Academic Press for the Linnaean Society, London: 312 pp.

Hayward, P.J. & Ryland, J.S. 1995. Bryozoa from Heron Island, Great Barrier Reef. 2. *Memoirs of the Queensland Museum*, **38**: 533-573.

Hayward, P.J. & Winston, J.E. 2011. Bryozoa collected by the United States Antarctic Research Program: new taxa and new records. *Journal of Natural History*, **46**: 2259-2338.

Hincks, T. 1877. On British Polyzoa. Part II. Classification. *Annals and Magazine of Natural History (series 4)*, **20**: 520-532.

Hincks, T. 1879. On the classification of the British Polyzoa. *Annals and Magazine of Natural History (series 5)*, **3**: 153-164.

Hincks, T. 1880. *A History of the British Marine Polyzoa (in two volumes).* Vol. 1, John Van Voorst, London: 601 pp.

Hincks, T. 1884. Contributions towards a general history of the marine Polyzoa. Part XII. Polyzoa from India (coast of Burmah). XIII. Polyzoa from Victoria and Western Australia. *Annals and Magazine of Natural History (series 5)*, **13**: 356-369.

Hincks, T. 1895. Contributions towards a general history of the marine Polyzoa, 1880-1891. Appendix (no. 5): 1-6.

Johnston, G. 1838. *A history of British zoophytes*. Lizars, Edinburgh, London & Dublin: 341 pp.

Jullien, J. 1883. Dragages du 'Travailleur'. Bryozoaires, espèces draguées dans l'Océan Atlantique en 1881. *Bulletin de la Société Zoologique de France,* **7**: 497-529.

Jullien, J. 1886. Les Costulidées, nouvelle famille de Bryozoaires. *Bulletin de la Société Zoologique de France*, **11**: 601-620.

Jullien, J. 1888. Bryozoaires. *Mission scientifique du Cap Horn, 1882-83*, **6**: 1-92.

Jullien, J. & Calvet, L. 1903. Bryozoaires provenant des campagnes de l'Hirondelle (1886-1888). *Resultats des campagnes scientifiques accomplies sur son yacht par Albert Ier, Prince Souverain de Monaco,* **23**: 1-188.

Kirkpatrick, R. 1888. Polyzoa of Mauritius. *Annals and Magazine of Natural History (series 6)*, **1**: 72-85.

Kirkpatrick, R. 1890. Reports on the zoological collections made in Torres Straits by Professor A.C. Haddon, 1888-1889. Hydroida and Polyzoa. *Scientific Proceedings of the Royal Dublin Society, New Series*, **6**: 603-626.

Lamouroux, J.V.F. 1821. *Exposition méthodique des genres de l'ordre des polpiers*. Agasse, Paris: 115 pp.

Levinsen, G.M.R. 1909. *Morphological and systematic studies on the cheilostomatous Bryozoa*. Nationale Forfatterers Forlag, Copenhagen: 431 pp.

Lu, L.-h 1989. Pliocene and Pleistocene Bryozoa from the East China Sea. *Cenozoic-Mesozoic Palaeontology and Stratigraphy of East China*, **3**: 21-44.

MacGillivray, P.H. 1883. Descriptions of new or little known Polyzoa, parts 2, 3 and 4. *Transactions and Proceedings of the Royal Society of Victoria*, **19**: 130-138, 191-195, 287-293.

MacGillivray, P.H. 1895. A monograph of the Tertiary Polyzoa of Victoria. *Transactions of the Royal Society of Victoria*, **4**: 1-166.

Michelin, H. 1848. *Iconographie zoophytologique, description par localités et terrains des polypiers fossils de France et pays environnants, 1.* Bertrand, Paris: 348 pp.

Moyano, G.H.I. 1991. Bryozoa marinos chilenos VIII. Una síntesis zoogeográfica con consideraciones sistemáticas y la descripción de diez especies y dos géneros nuevos. *Gayana Zoologia, Concepción*, **55**: 305-389.

Neviani, A. 1895. Briozoi neozoici di alcune località d'Italia. Parte 1. *Bollettino della Società Romana per gli studi Zoologici*, **4**: 109-123.

Norman, A.M. 1868. Notes on some rare British Polyzoa, with descriptions of new species. *Quarterly Journal of Microscopical Science,* **8**: 212-222.

Norman, A.M. 1869. Last report on dredging among the Shetland Islands. Polyzoa. *Report of the British Association for the Advancement of Science, London,* **1868**: 303-312.

Norman, A.E. 1903. Notes on the natural history of East Finmark. Polyzoa. *Annals and Magazine of Natural History (series 7)*, **11**: 567-598.

Ortmann, A. 1892. Die Korallriffe von Dar-es-Salaam und Umgegend. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere,* **6**: 631-670.

Osburn, R.C. 1927. The Bryozoa of Curaçao. *Bijdragen tot de Dierkunde, Amsterdam,* **25**: 123-132

Osburn, R.C. 1940. Bryozoa of Porto Rico with a résumé of the West Indian bryozoan fauna. *New York Academy of Sciences, Scientific Survey of Porto Rico and the Virgin Islands*, **16**: 321-486.

Osburn, R.C. 1950. Bryozoa of the Pacific coast of America, part 1, Cheilostomata-Anasca. *Report of the Allan Hancock Pacific Expeditions,* **14**: 1-269.

Osburn, R.C. 1952. Bryozoa of the Pacific coast of America, part 2, Cheilostomata-Ascophora. *Report of the Allan Hancock Pacific Expeditions,* **14**: 271-611.

Pallas, P.S. 1766. *Elenchus zoophytorum sistens generum adumbrationes generaliores et speciarum cognitarum succintas descriptiones cum selectis auctorus synonymis*. Petrum van Cleef, Hagae-Comitum: 451 pp.

Pouyet, S. 1976. Bryozoaires cheilostomes du Pliocène d'Aguilas (Espagne meridionale). *Nouvelles Archives du Museum d'Histoire Naturelle, Lyon,* **14**: 53-82.

Pouyet, S. & Moissette, P. 1986. Bryozoaires cheilostomes nouveaux du Miocène supérieur du bassin d'Alboran (Méditerranée occidentale). *Geobios,* **19**: 385-391.

Reuss, A.E. 1847. Die fossilen Polyparien des Wiener Tertiärbeckens. *Haidingers Naturwissenschaftlichen Abhandlungen,* **2**: 1-109.

Reuss, A.E. 1874. Die fossilen Bryozoen des Österreichisch-Ungarischen Miocäns. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Wien*, **33**: 141-190.

Ridley, S.O. 1881. Account of the zoological collections made during the survey of H.M.S. Alert in the straits of Magellan and on the coast of Patagonia. *Proceedings of the Zoological Society of London,* **1881**: 44-61.

Ristedt, H. 1985. *Cribrilaria*-Arten (Bryozoa) des Indopazifiks (Rotes Meer, Seychellen, Philippinen). *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg*, **59**: 15-38.

Ryland, J.S. 1963. Systematic and biologic studies on Polyzoa (Bryozoa) from western Norway. *Sarsia,* **14**: 1-59.

Ryland, J.S. 1969. A nomenclatural index to 'A history of the British Marine Polyzoa' by T. Hincks (1880). *Bulletin of the British Museum (Natural History), Zoology,* **17**: 207-260.

Ryland, J.S. & Hayward, P.J. 1992. Bryozoa from Heron Island, Great Barrier Reef. *Memoirs of the Queensland Museum*, **32**: 223-301.

Schmid, B. 1989. Cheilostome Bryozoen aus dem Badenien (Miozän) von Nussdorf (Wien). *Beiträge zur Paläontologie und Geologie* ***Österreich****-Ungarns und des Orients*, **15**: 1-101.

Scholz, J. 1991. Monsoon-related settlement patterns in reef- and harbor bryozoans, Philippines. *In*: Bigey, F.P. & d'Hondt, J.-L. (Eds.), Bryozoaires Actuels et Fossiles. *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France Mémoire HS,* **1**: 409-416.

Sendino, C. & Taylor, P. D. 2014. Pliocene bryozoans from Gran Canaria. *Studi Trentini di Scienze Naturali*, **94**: 229-239.

Silén, L. 1947. Conescharellinidae (Bryozoa Gymnolaemata) collected by Prof. Dr. Sixten Bock's expedition to Japan and the Bonin Islands 1914. *Arkiv för Zoology,* **39A**: 1-59.

Smitt, F.A. 1868. Kritisk Förteckning öfver Skandinaviens Hafs-Bryozoer. IV. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar,* **24**: 279-429.

Smitt, F.A. 1873. Floridan Bryozoa, collected by Count L.F. de Pourtales. II. *Kongliga Svenska Vetenskaps-Akademiens Handlingar,* **11**: 1-83.

Soule, D.F. & Soule, J.D. 1973. Morphology and speciation of Hawaiian and eastern Pacific Smittinidae (Bryozoa, Ectoprocta). *Bulletin of the American Museum of Natural History,* **152** (6): 365-440.

Soule, J.D., Soule, D.F. & Chaney, H.W. 1991. New tropical Pacific and Indian Ocean Cleidochasmatidae (Cheilostomata: Ascophora). *In*: Bigey, F.P. & d'Hondt, J.-L. (Eds.), Bryozoaires Actuels et Fossiles. *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France Mémoire HS,* **1**: 465-486.

Taylor, P.D. & Foster, T.S. 1994. Bryozoa from the Plio-Pleistocene of Tobago, West Indies. *Tertiary Research*, **15**: 1-16.

Taylor, P.D. & Mawatari, S.F. 2005. Preliminary overview of the cheilostome bryozoan *Microporella*. *In*: Moyano, G., Hugo, I., Cancino, J.M. & Wyse-Jackson, P.N. (Eds.), *Bryozoan Studies 2004*: 329-339. A.A. Balkema Publishers, Leiden, London, New York, Philadelphia, Singapore.

Tewari, B.S., Bhargava, O.N. & Tandon, K.K. 1958. Two cheilostome Bryozoa from Lower Miocene beds of Kutch. *Journal of Palaeontological Society of India*, **3**: 233-235.

Tewari, B.S. & Srivastava, A. 1967. On some fossil Bryozoa from India. *Journal of the Geological Society of India,* **8**: 18-28.

Thornely, L.R. 1905. Report on the Polyzoa collected by Professor Herdmann, at Ceylon, in 1902. *Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manar,* **4**: 107-130.

Thornely, L.R. 1912. Marine Polyzoa of the Indian Ocean. *Transactions of the Linnean Society of London*, **15**: 137-157.

Tilbrook, K.J. 1999. Description of *Hippopodina feegeensis* and three other species of *Hippopodina* Levinsen, 1909 (Bryozoa: Cheilostomatida). *Journal of Zoology, London*, **247**: 449-456.

Tilbrook, K.J. 2001. Indo-West Pacific species of the genus *Stylopoma* Levinsen, 1909 (Bryozoa: Cheilostomata). *Zoological Journal of the Linnean Society*, **131**: 1-34.

Tilbrook, K.J. 2006. Cheilostomatous Bryozoa from the Solomon Islands. *Santa Barbara Museum of Natural History, Monographs* **4** (Studies in Biodiversity Number **3**): 1-386.

Tilbrook, K.J. 2012. Review of the bryozoan genus *Bryopesanser* Tilbrook, 2006 (Escharinidae: Cheilostomata) with the description of 11 new species. *Zootaxa*, **3165**: 39-63.

Tilbrook, K.J., Hayward, P.J. & Gordon, D.P. 2001. Cheilostomatous Bryozoa from Vanuatu. *Zoological Journal of the Linnean Society*, **131**: 35-109.

Vigneaux, M. 1949. Révision des Bryozoaires néogènes du Bassin d'Aquitaine et essai de classification. *Mémoires de la Société Géologique de France* (nouvelle série), **28**: 1-153.

Waters, A.W. 1891. North-Italian Bryozoa. *Quarterly Journal of the Geological Society, London*, **47**: 1-34.

Waters, A.W. 1899. Bryozoa from Madeira. *Journal of the Royal Microscopical Society*, **1899**: 6-16.

Waters, A.W. 1907. *Tubucellaria*: its species and ovicells. *Journal of the Linnean Society (Zoology), London*, **30**: 126-133.

Waters, A.W. 1913. The marine fauna of British East Africa and Zanzibar, from collections made by Cyril Crossland M.A., B. Sc., F.Z.S., in the years 1901-1902. Bryozoa - Cheilostomata. *Proceedings of the Zoological Society of London*, **1913**: 458-537.

Winston, J.E. 1986. An annotated check-list of coral-associated bryozoans. *American Museum Novitates*, **2859**: 1-39.

Winston, J.E. 2005. Re-description and revision of Smitt's "Floridan Bryozoa" in the collection of the Museum of Comparative Zoology, Harvard University. *Virginia Museum of Natural History Memoir*, **7**: 1-147.

Winston, J.E. & Beaulieu, S.E. 1999. *Striatodoma dorothea* (Cheilostomatida: Tessaradomidae), a new genus and species of bryozoan from deep water off California. *Proceedings of the Biological Society of Washington*, **112**: 313-318.

Zágoršek, K. 2010. Bryozoa from the Langhian (Miocene) of the Czech Republic. Part II: Systematic description of the Suborder Ascophora Levinsen, 1909 and paleoecological reconstruction of the studied paleoenvironment. *Sborník Národního Musea v Praze, Řada B – Přírodní vědy, Acta Musei Nationalis Pragae (Series B – Historia Naturalis)*, **66**: 139-255.

Table 1. Species list with known ranges. OR = oldest range limit. TFR = Miocene range from 'Through-flow' samples (LB = Late Burdigalian, B/L = Burdigalian Langhian boundary, L = Langhian, S = Serravallian, T = Tortonian, M = Messinian); YR = youngest range limit.

Species	**OR**	**TFR**						**YR**
		LB	**B/L**	**L**	**S**	**T**	**M**	
Antoniettella exigua		X	X		X		X	
?*Filaguria kalimantanensis* sp. nov.					X			
Puellina cf. *voigti*		X	X	X	X			Recent
Puellina bontangensis sp. nov.		X	X	X	X			
Puellina sp.			X					
Caberoides gordoni sp. nov.		X						
Trypostega hasibuani sp. nov.		X			X			
Poricella sp.					X			
Exechonella sp.					X			
Oviexechonella digeronimoi sp. nov.					X			
Adeonellopsis aff. *obliqua*		X						
Adeonellopsis sp. 1			X					
Adeonellopsis sp. 2					X			
Reptadeonella curvabilis sp. nov.			X					
Reptadeonella toddi sp. nov.			X		X			
Celleporaria sp.					X			
?*Hippomenella devatasae* sp. nov.		X						
?*Hippomenella uniserialis* sp. nov.		X						
?*Umbonula* sp.				X				
Sendinopora prima sp. nov.					X			
Parasmittina sp.		X			X			
?*Pleurocodonellina* sp.		X						
Smittina sp.		X						
Smittoidea cf. *pacifica*		X						Recent
Stylopoma sp. 1					X			
Stylopoma sp. 2						X		
Stylopoma sp. 3							X	
Margaretta aff. *gracilior*		X						Recent
Margaretta aff. *tenuis*		X						Recent
Margaretta aff. *watersi*					X			Recent
Margaretta amitabhae sp. nov.			X		X			
Hippopodina feegeensis					X	X		Recent
Hippopodina cf. *pulcherrima*							X	Recent
Hippopodina indicata sp. nov.		X	X	X				
Saevitella renemai sp. nov.		X						
Thornelya sp.					X			

cont. Table 1

Species	**OR**	**TFR**						**YR**
		LB	**B/L**	**L**	**S**	**T**	**M**	
Gigantopora milenae sp. nov.					X			
Calyptotheca sp. 1		X			X			
Calyptotheca sp. 2					X			
Actisecos sp. 1		X						
Actisecos sp. 2					X			
Vix sp.			X					
Orbiculipora sp.		X						
Calloporina sp.					X			
Microporella aff. *browni*					X			Recent
Microporella aff. *coronata*		X						Recent
Microporella sp.			X					
Arthropoma renipora sp. nov.		X						
Bryopesanser bragai sp. nov.		X			X			
Bryopesanser sanfilippoae sp. nov.			X	X	X			
Tubiporella magnipora sp. nov.		X						
Anoteropora cf. *magnicapitata*					X			Recent
Cigclisula aff. *ramparensis*	Burdigalian			X				
Cigclisula sp. 1						X		
Cigclisula sp. 2						X		
Trematooecia sp.		X			X			
Buffonellaria sagittaria sp. nov.		X						
Lagenipora sciutoi sp. nov.		X						
Predanophora sp.		X	X	X	X			
Turbicellepora aff. *canui*	Aquitanian			X				
Scorpiodinipora cf. *costulata*							X	Recent
?*Lifuella* sp. 1		X						
?*Lifuella* sp. 2					X			
Plesiocleidochasma cf. *laterale*		X						Recent
Plesiocleidochasma sp. 1					X			
Plesiocleidochasma sp. 2							X	
Rhynchozoon sp.						X		
Stephanollona sp.		X			X			
Triphyllozoon sp.		X			X			
Phidoloporidae sp. 1		X						
Phidoloporidae sp. 2		X						
Phidoloporidae sp. 3			X		X			

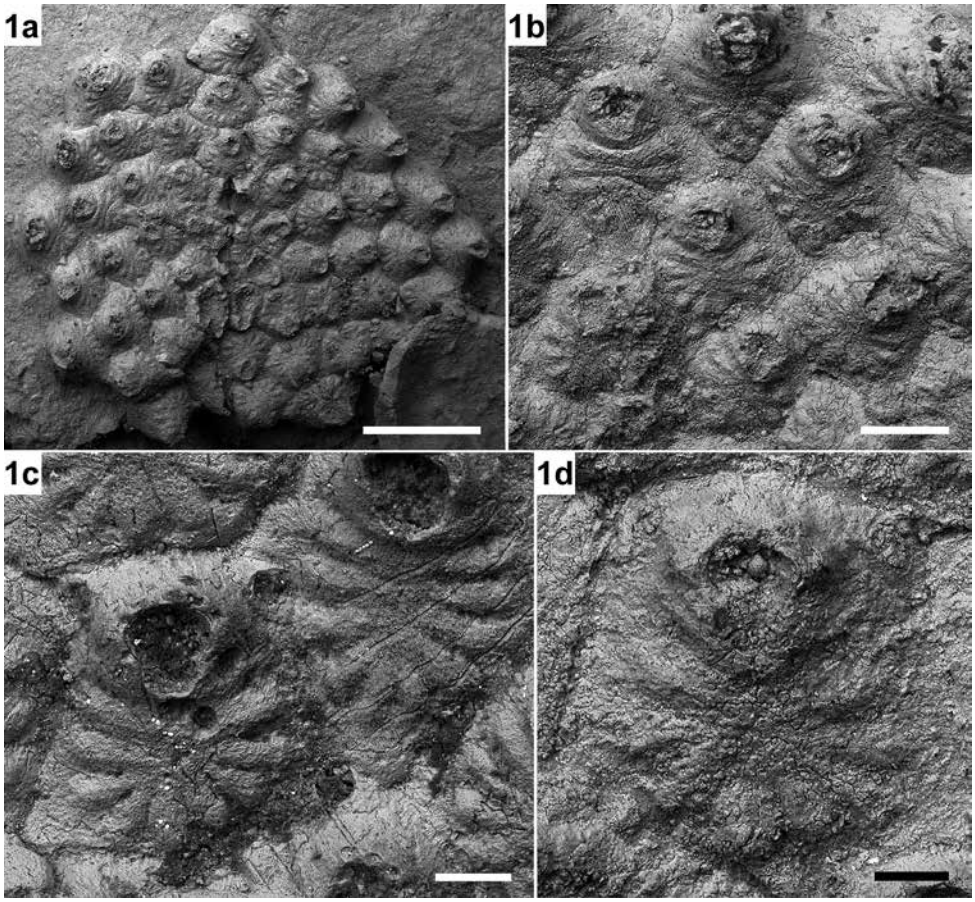


Plate 1

Antoniettella exigua Di Martino & Taylor, 2012a
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 5842. a, view of entire colony; scale bar = 500 μm. b, group of autozooids; scale bar = 200 μm. c, pentagonal autozooid; scale bar = 100 μm. d, hexagonal autozooid; scale bar = 100 μm.

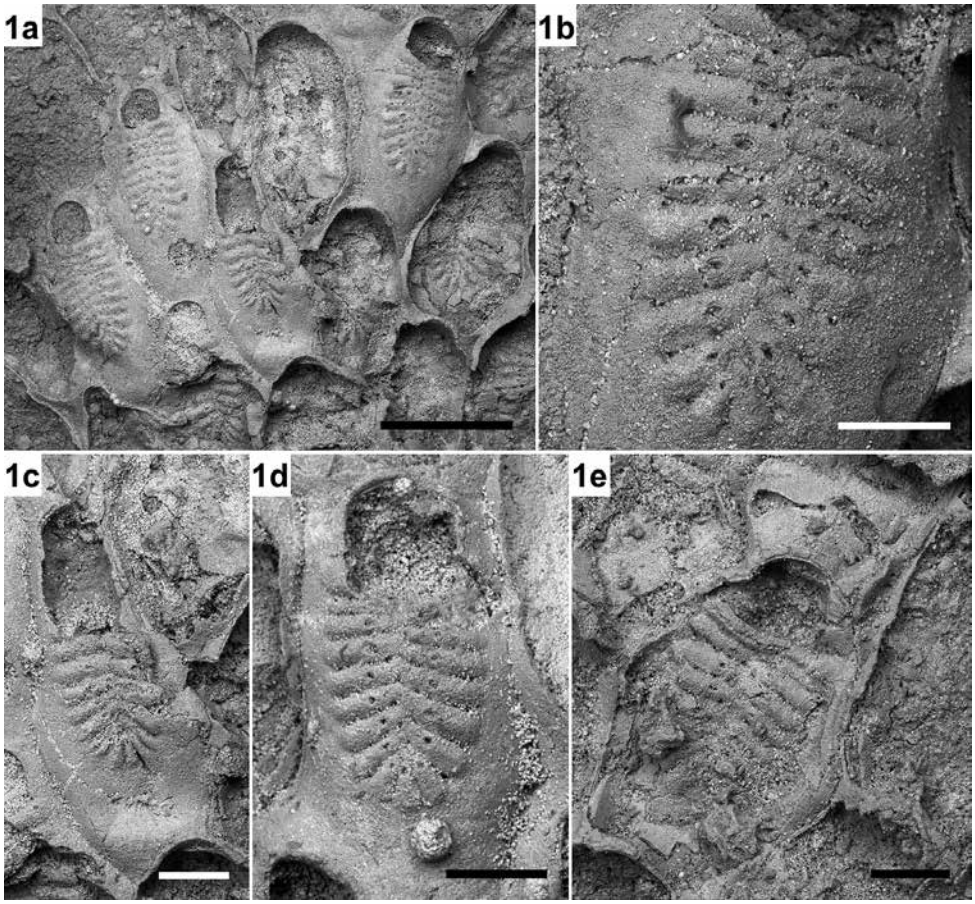


Plate 2

?*Filaguria kalimantanensis* sp. nov.
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. Holotype: NHMUK PI BZ 6900. a, view of a few preserved zooids; scale bar = 1 mm. b, frontal shield; scale bar = 150 μm. c, ?vicarious avicularium; scale bar = 150 μm. d, autozooid; scale bar = 150 μm. e, ovicellate zooid; scale bar = 150 μm.

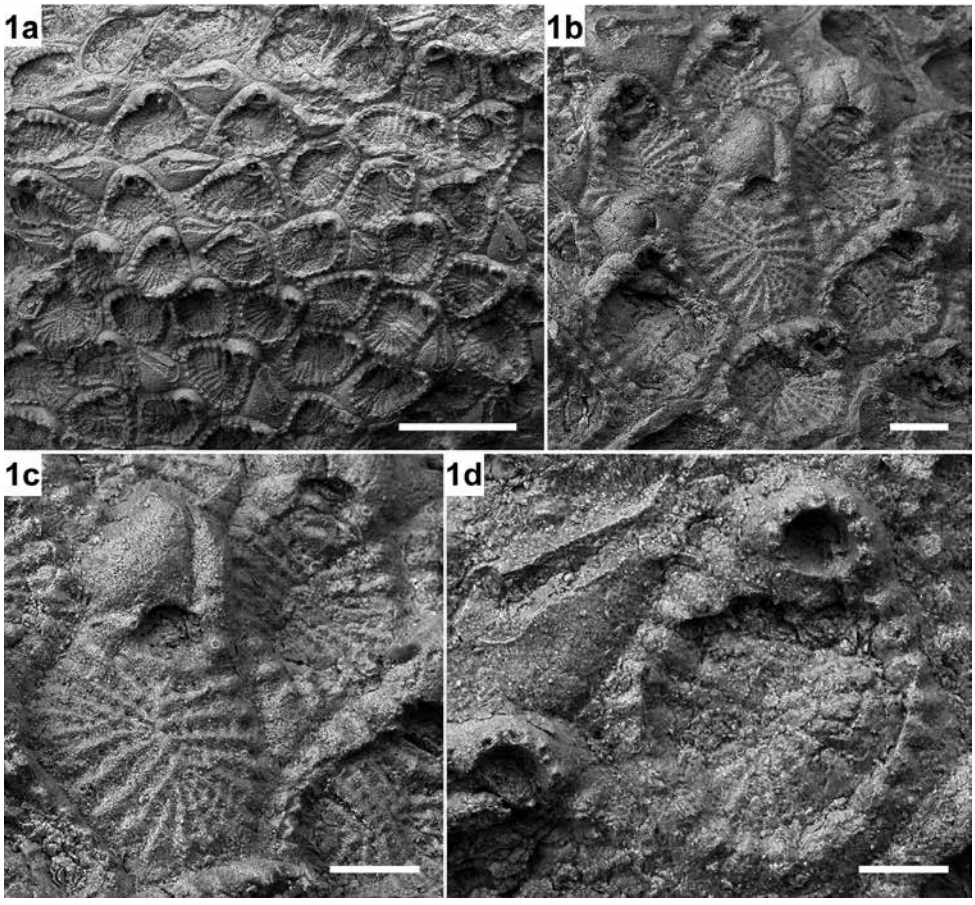


Plate 3

Puellina cf. *voigti* (Ristedt, 1985)
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6901. a, part of the colony; scale bar = 500 μm. b, group of ovicellate and non-ovicellate zooids; scale bar = 100 μm. c, ovicellate zooid; scale bar = 100 μm. d, autozooid with six oral spine bases, and an interzooidal avicularium; scale bar = 100 μm.

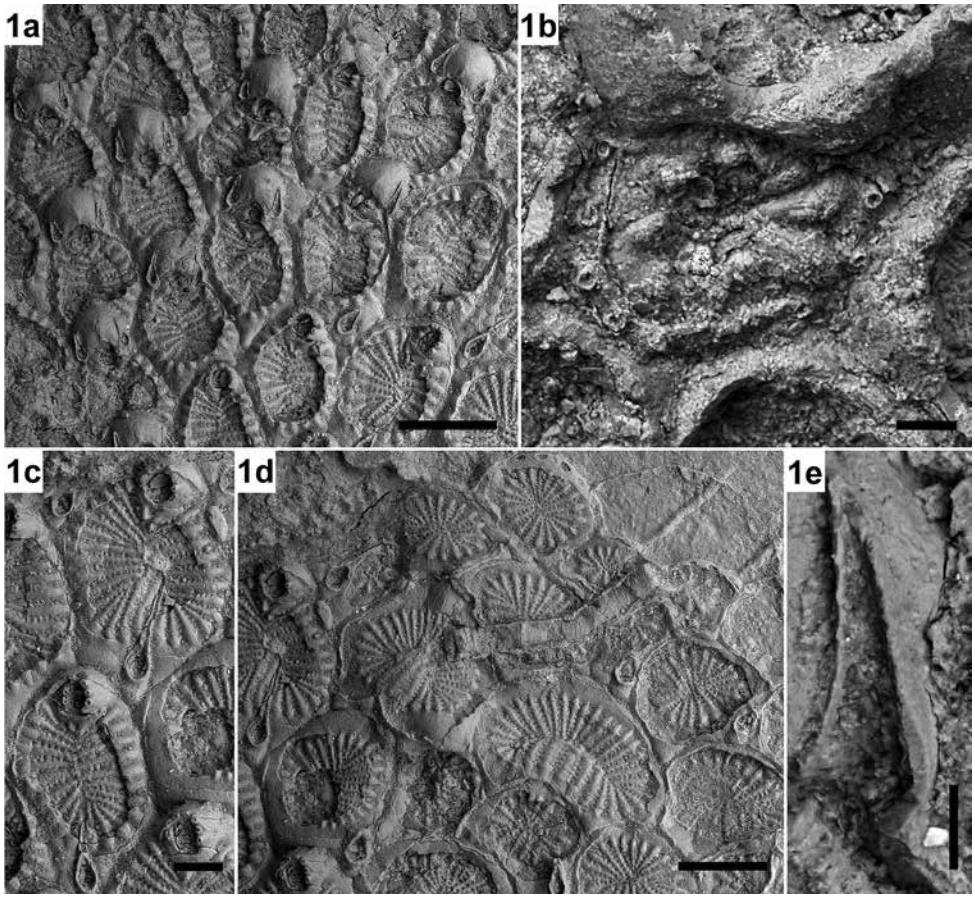


Plate 4

Puellina bontangensis sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6902. a, part of the colony showing numerous ovicellate zooids; scale bar = 300 μm. b, tatiform ancestrula; scale bar = 20 μm. c, two autozooids and long, interzooidal avicularia; scale bar = 100 μm. d, kenozooids at the colony growing edge showing basal pore chamber windows; scale bar = 300 μm. e, an adventitious avicularium, placed lateral to the ooecium, with pointed rostrum and serrated lateral edges; scale bar = 20 μm.

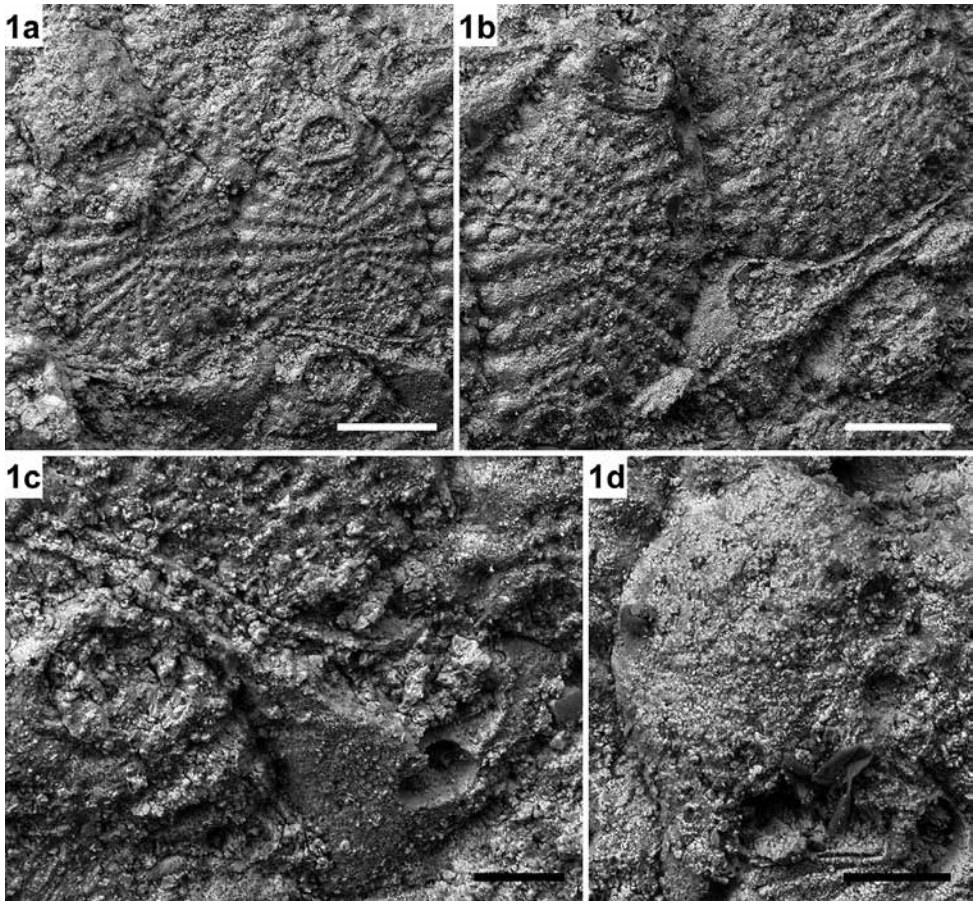


Plate 5

Puellina sp.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. NHMUK PI BZ 6903. a, autozooid, ovicellate zooid and interzooidal avicularium; scale bar = 150 μm. b, autozooid and interzooidal avicularium; scale bar = 100 μm. c, interzooidal avicularium; scale bar = 50 μm. d, close-up of an ooecium; scale bar = 50 μm.

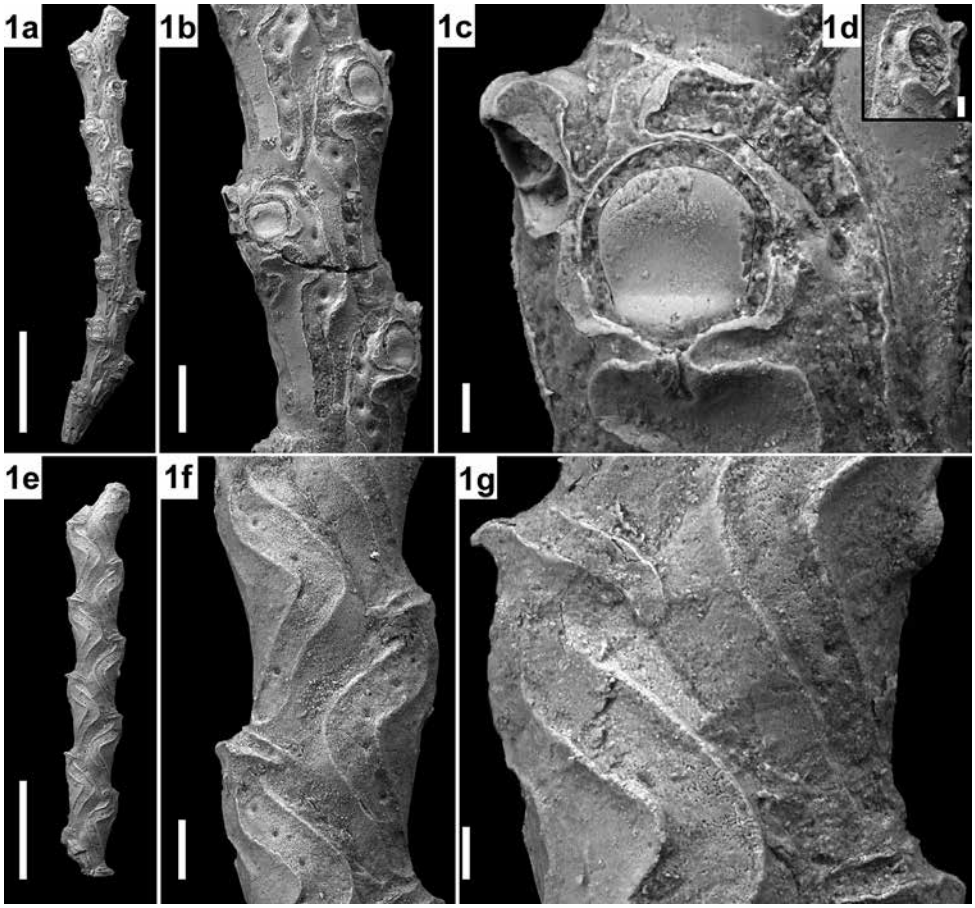


Plate 6

Caberoides gordoni sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-d, Holotype NHMUK PI BZ 6904. a, frontal view of branch fragment; scale bar = 500 μm. b, two autozooids; scale bar = 100 μm. c, orifice, ?operculum, and avicularium; scale bar = 20 μm. d, primary orifice; scale bar = 20 μm. e-g, Paratype NHMUK PI BZ 6905. e, dorsal view of branch fragment; scale bar = 500 μm. f, close-up of dorsal side; scale bar = 100 μm. g, vibraculum-like chamber; scale bar = 50 μm.

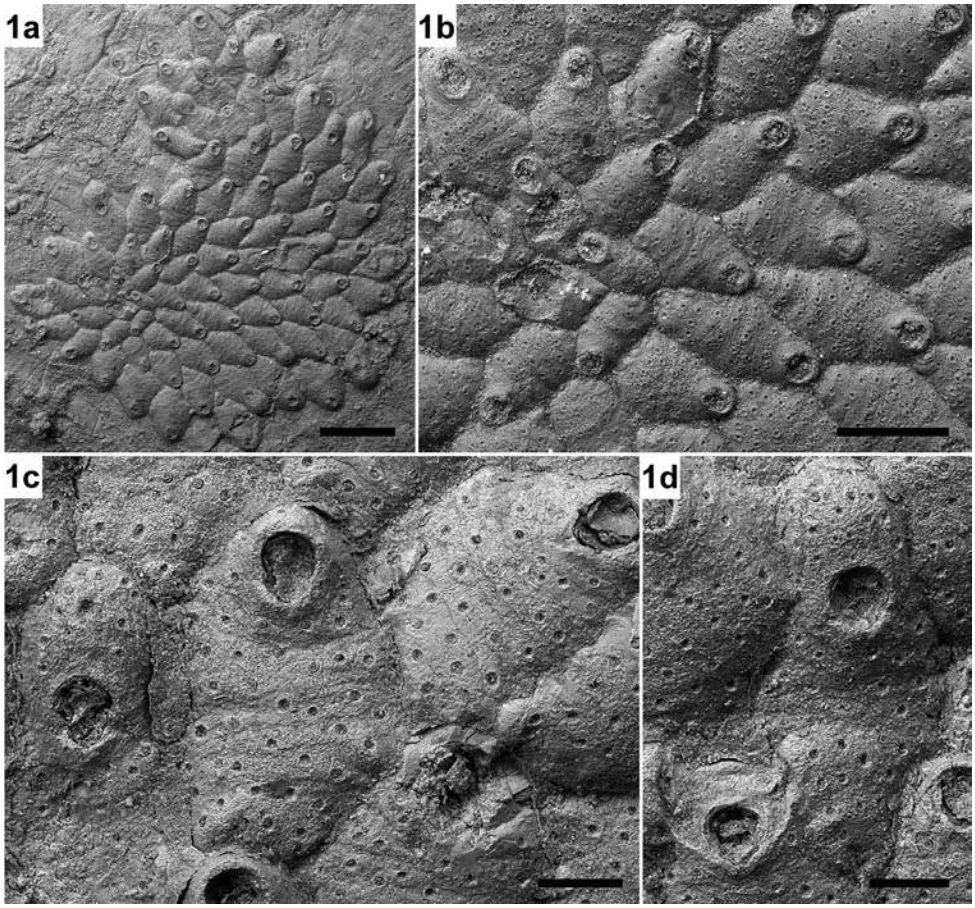


Plate 7

Trypostega hasibuani sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6906. a, general view of a colony; scale bar = 500 μm. b, ancestrula and periancestrular zooids; scale bar = 200 μm. c, autozooid and ovicellate zooid; scale bar = 100 μm. d, ovicellate zooid; scale bar = 100 μm.

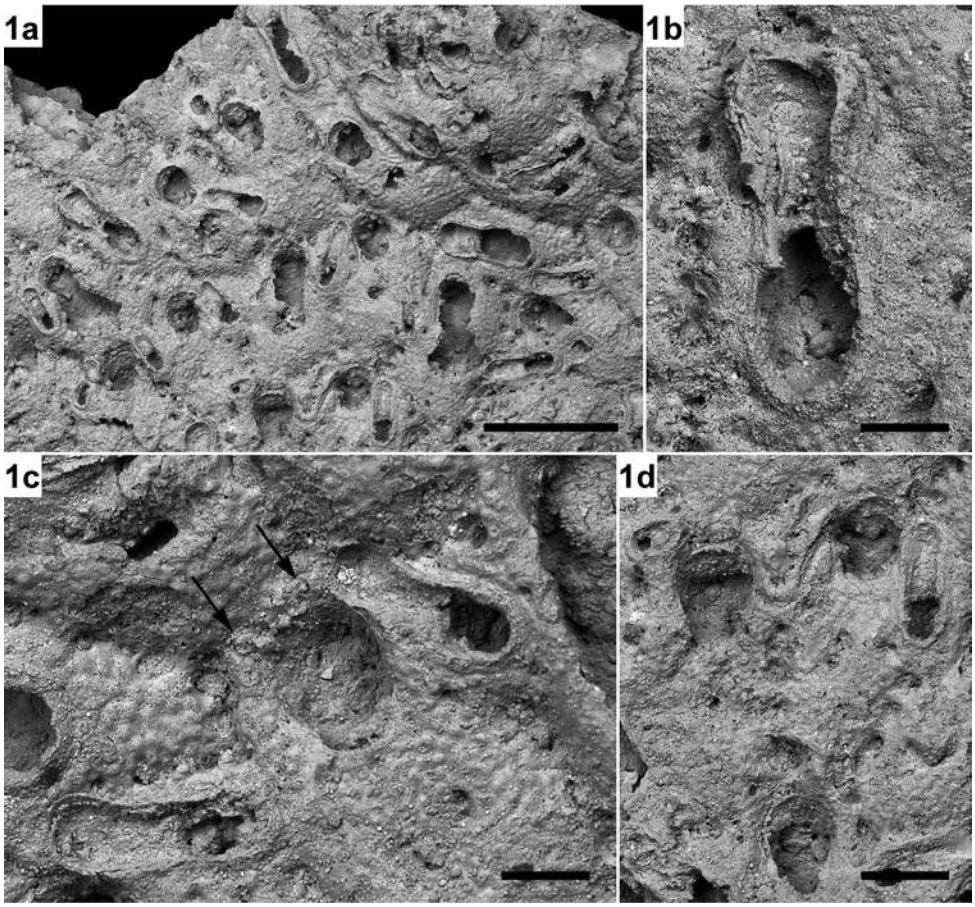


Plate 8

Poricella sp.
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. NHMUK PI BZ 6907. a, view of part of a colony; scale bar = 500 μm. b, large, spatulate, vicarious avicularium; scale bar = 100 μm. c, oblique close-up of an orifice with two oral spine bases (see arrows), and interzooidal avicularia; scale bar = 100 μm. d, group of autozooids and interzooidal avicularia of varying size; scale bar = 150 μm.

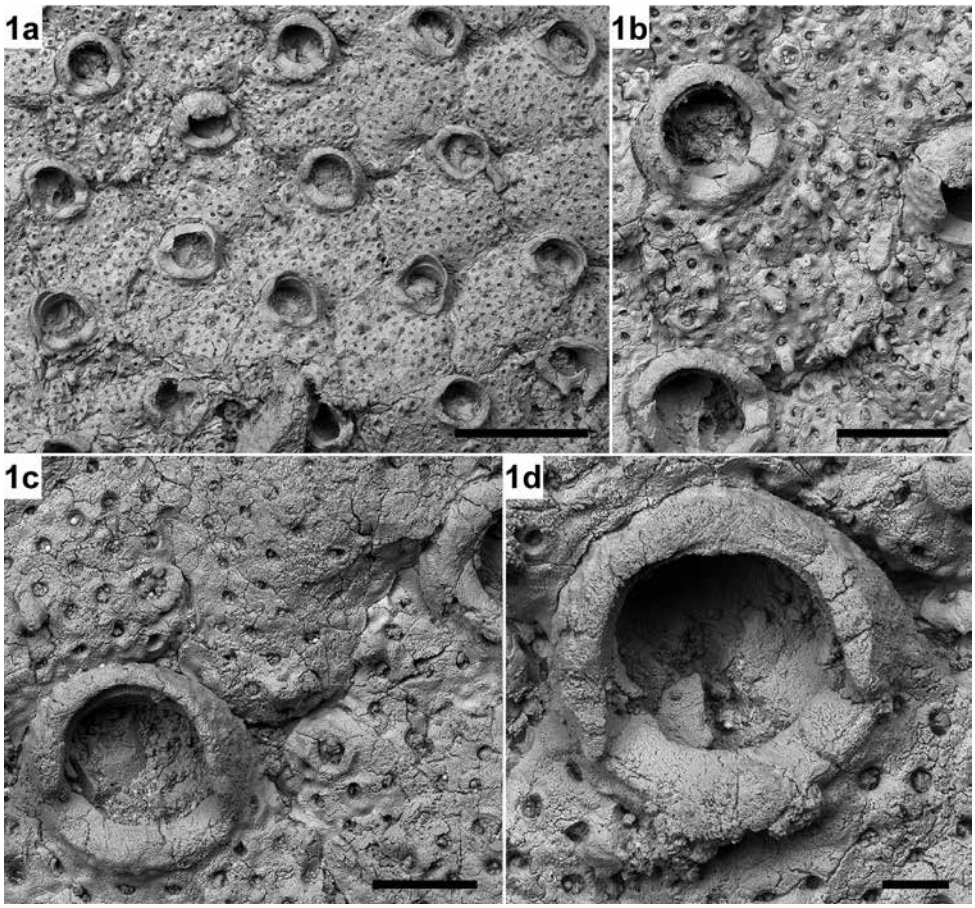


Plate 9

Exechonella sp.
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. NHMUK PI BZ 6908. a, group of zooids; scale bar = 500 μm. b, zooid showing frontal projections; scale bar = 200 μm. c, kenozooidal structures at the corners of two autozooids; scale bar = 150 μm. d, orifice and peristome; scale bar = 50 μm.

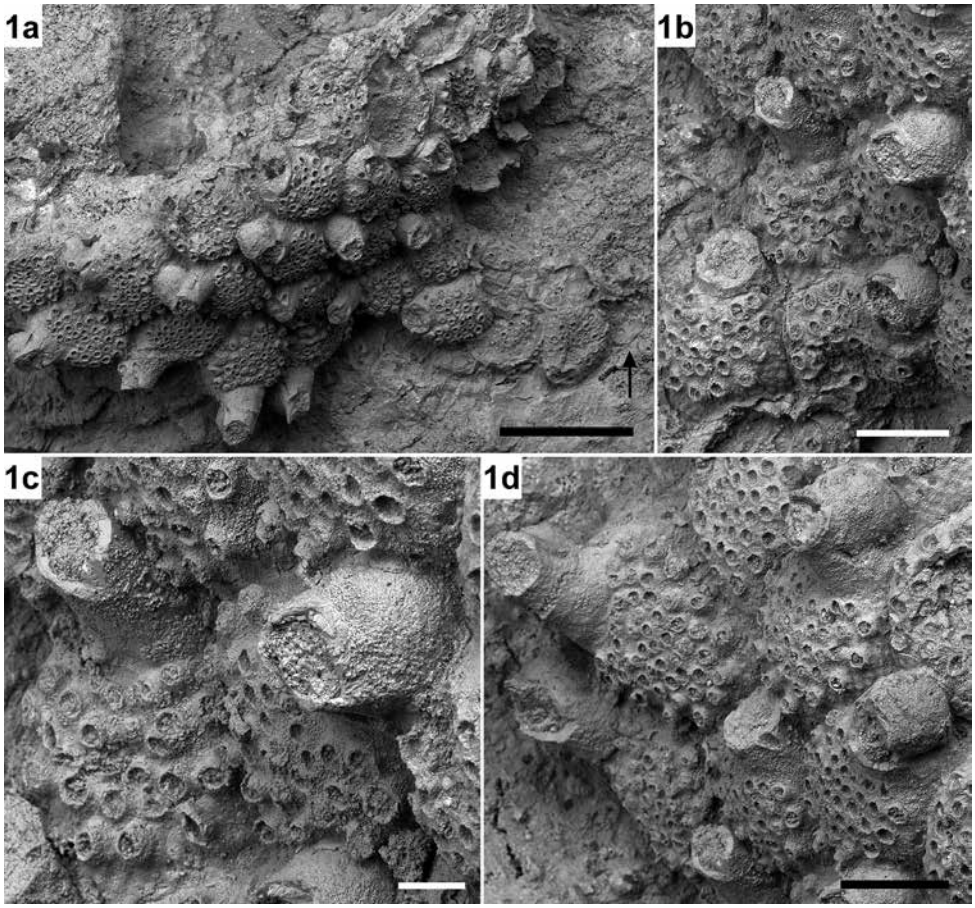


Plate 10

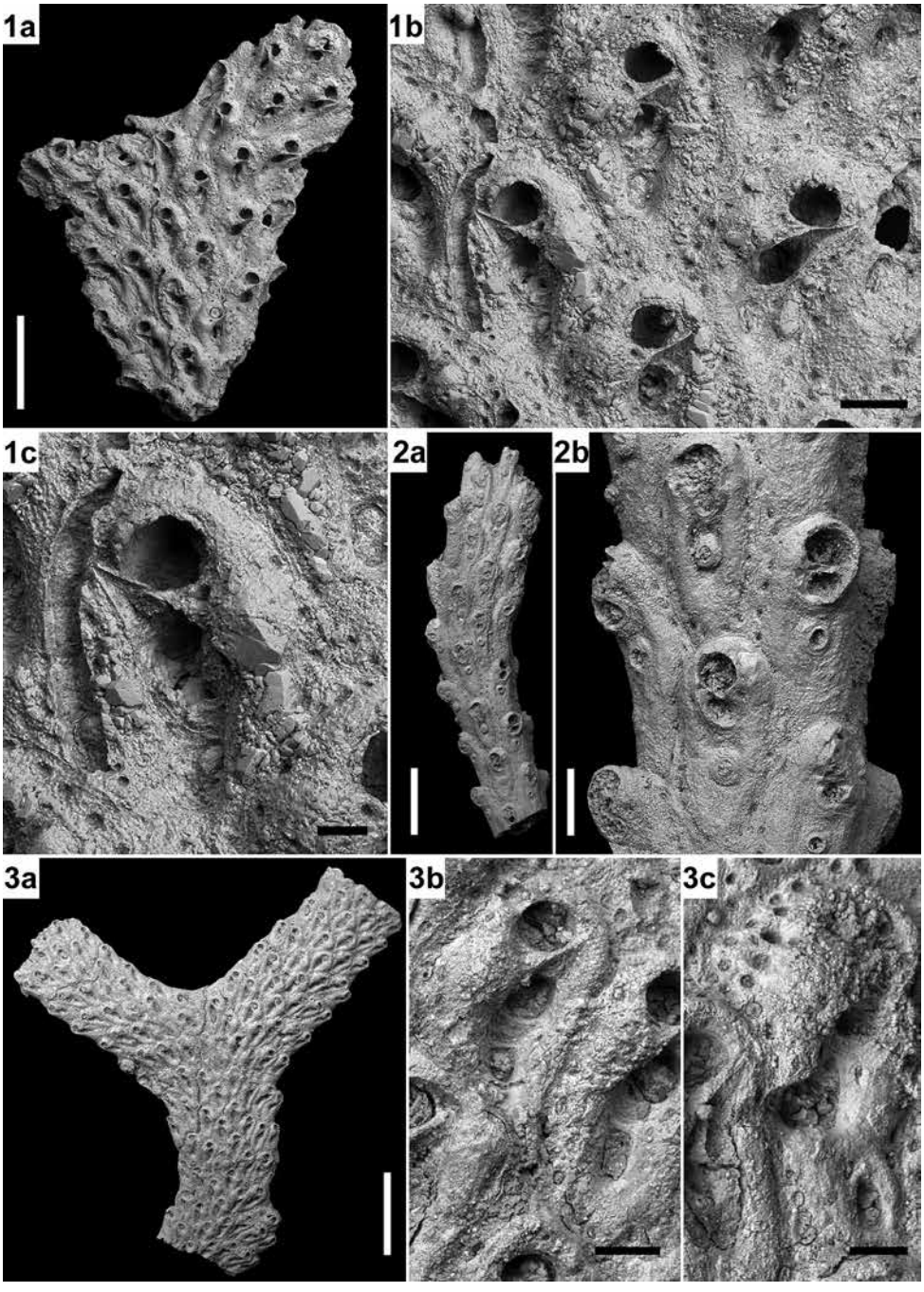
Oviexechonella digeronimoi gen. et sp. nov.
Serravallian, TF59, 'Southern Hemisphere', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6909. a, view of the colony (arrow indicates ancestrula outline); scale bar = 500 μm. b, group of zooids; scale bar = 200 μm. c, autozooid and ovicellate zooid; scale bar = 100 μm. d, group of ovicellate zooids; scale bar = 200 μm.

Plate 11

Adeonellopsis aff. *obliqua* MacGillivray, 1895
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6910. a, branch fragment; scale bar = 500 μm. b, group of autozooids; scale bar = 100 μm. c, autozooid and adventitious avicularium showing the trifoliate premandibular portion of the opesia; scale bar = 50 μm.

Adeonellopsis sp. 1
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 2. NHMUK PI BZ 6911. a, branch fragment; scale bar = 500 μm. b, group of autozooids; scale bar = 100 μm.

Adeonellopsis sp. 2
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 3. NHMUK PI BZ 6912. a, branch fragment; scale bar = 1 mm. b, autozooid; scale bar = 100 μm. c, damaged, ?maternal zooid; scale bar = 100 μm.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3a
3b
3c

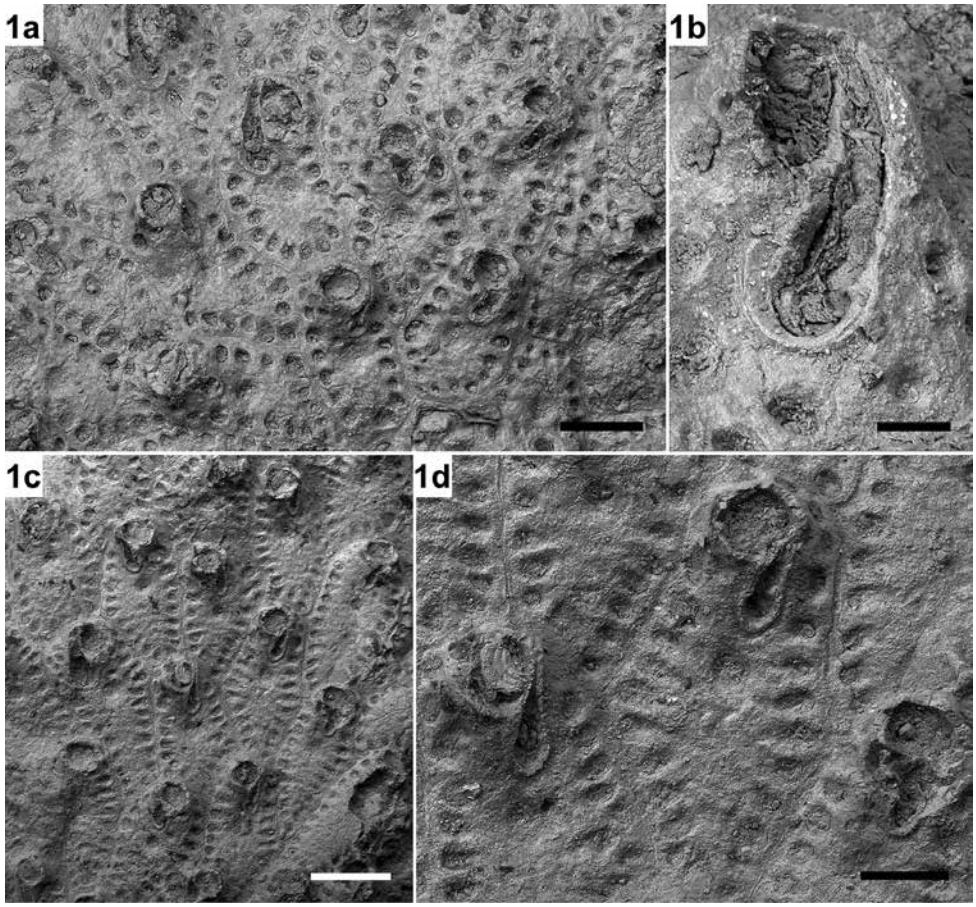


Plate 12

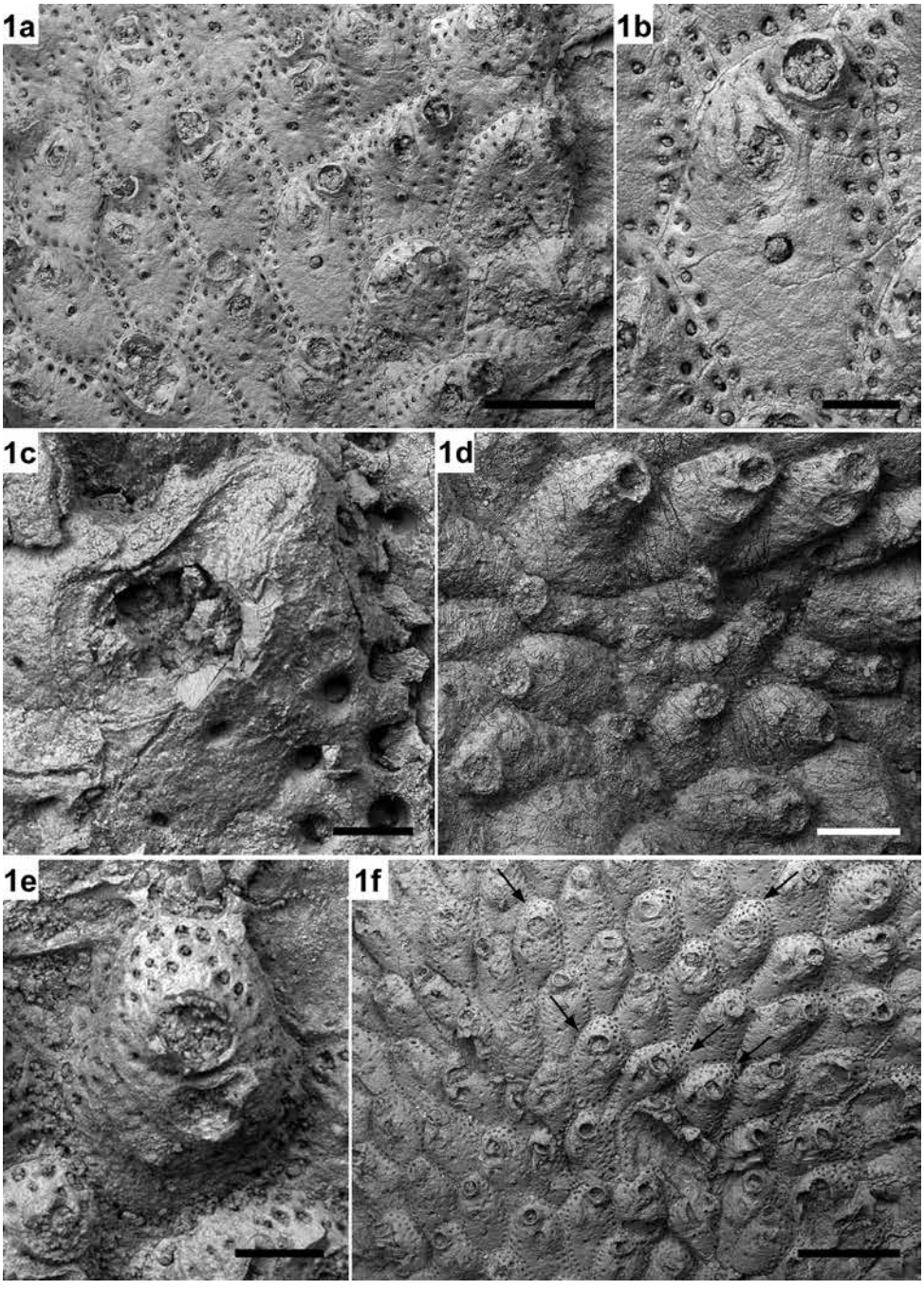
Reptadeonella curvabilis sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-b, Holotype: NHMUK PI BZ 6913. a, group of autozooids; scale bar = 200 μm. b, sickle-shaped avicularium; scale bar = 50 μm. c-d, Paratype: NHMUK PI BZ 6914. c, group of autozooids with small, slender, triangular avicularia; scale bar = 300 μm. d, autozooid; scale bar = 100 μm.

Plate 13 ▶

Reptadeonella toddi sp. nov.
Serravallian, TF51, 'Stadion Reef 1', Samarinda.
Fig. 1. a-c, Holotype: NHMUK PI BZ 6915. a, group of autozooids; scale bar = 500 μm. b, autozooid; scale bar = 150 μm. c, pear-shaped avicularium; scale bar = 50 μm.

Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. d, Paratype: NHMUK PI BZ 6916. Ancestrula and early astogeny; scale bar = 100 μm.

Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. e-f, Paratype: NHMUK PI BZ 6917. e, maternal zooid; scale bar = 150 μm. f, view of part of the colony with fertile zooids; scale bar = 1 mm.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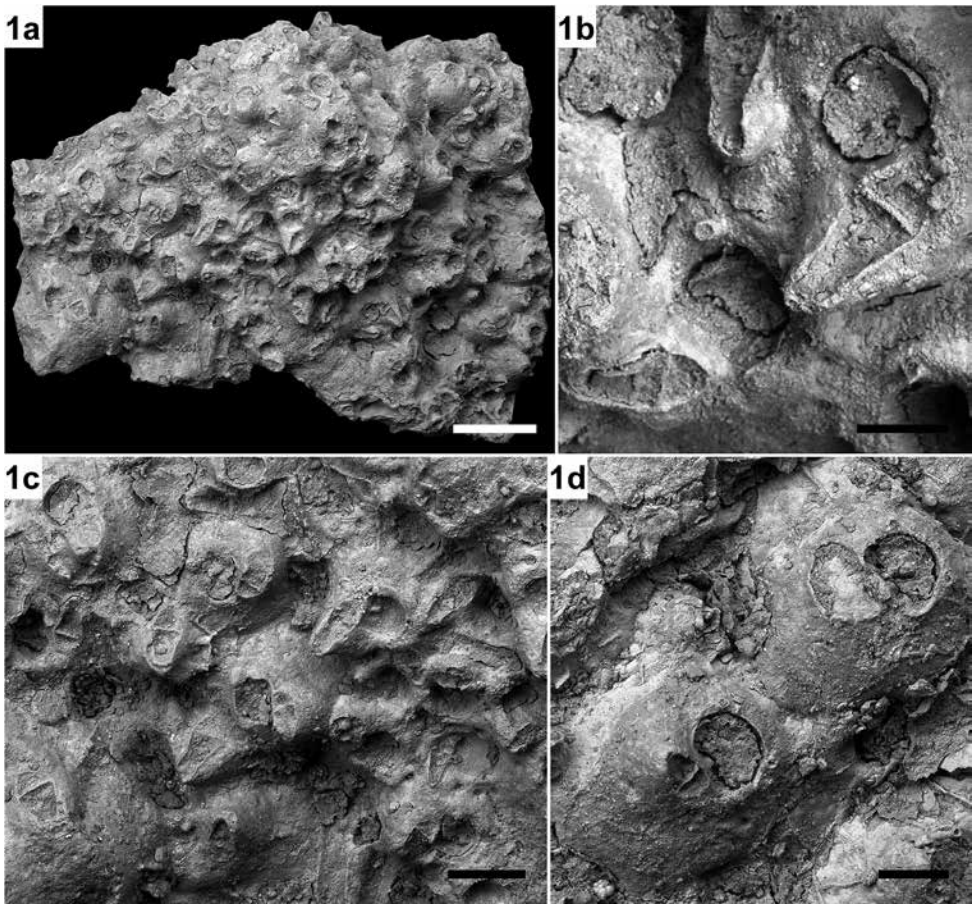


Plate 14

Celleporaria sp.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6918. a, mound-shaped colony; scale bar = 500 μm. b, two autozooids and suboral avicularia; scale bar = 100 μm. c, group of autozooids and avicularia; scale bar = 200 μm. d, two autozooids showing two distolateral oral spine bases and small suboral avicularia; scale bar = 100 μm.

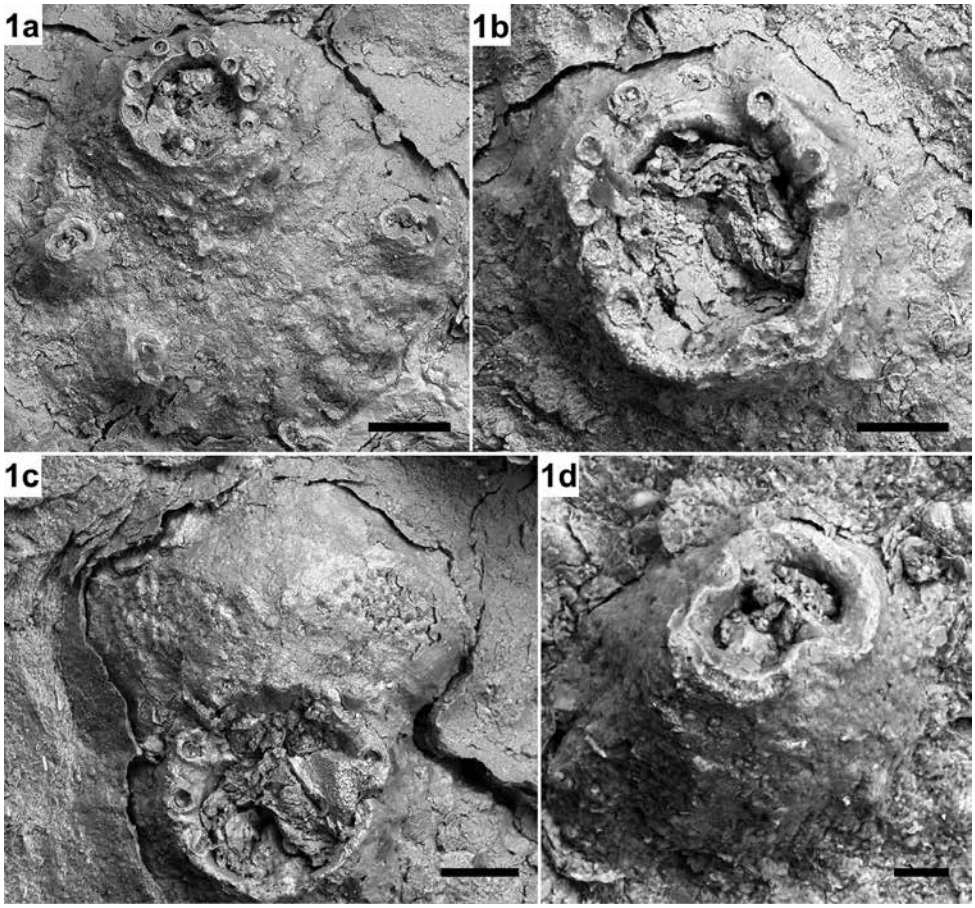


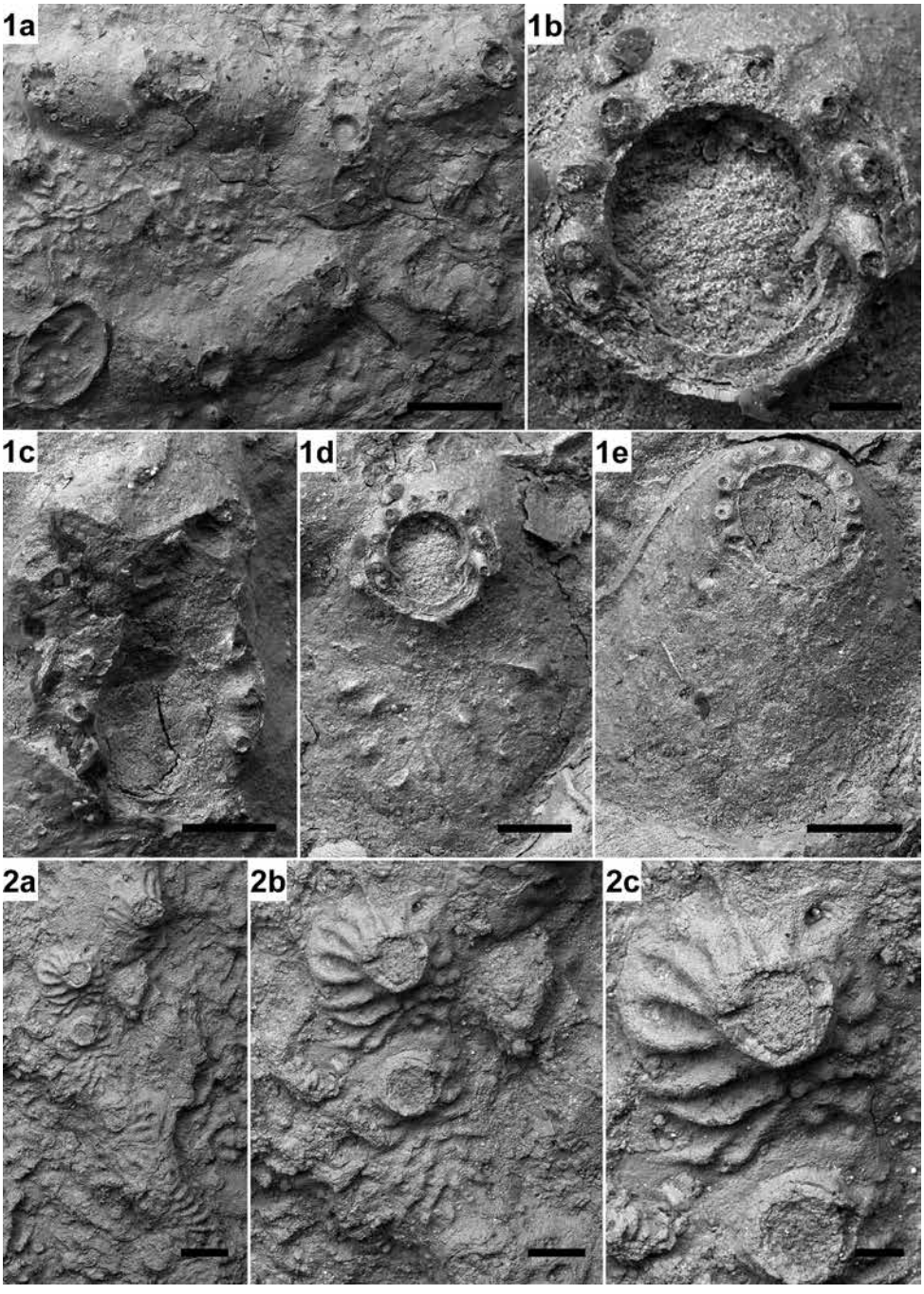
Plate 15

?*Hippomenella devatasae* sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6919. a, autozooid; scale bar = 100 μm. b, close-up of orifice with eight oral spine bases; scale bar = 50 μm. c, ooecium; scale bar = 50 μm. d, adventitious avicularium; scale bar = 20 μm.

Plate 16

?*Hippomenella uniserialis* sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, Holotype: NHMUK PI BZ 6920. a, view of a colony; scale bar = 500 μm. b, orifice with nine oral spine bases; scale bar = 50 μm. c, ooecium. d-e, Paratype: NHMUK PI BZ 6921. d, autozooid with ridged frontal shield; scale bar = 150 μm. e, autozooid; scale bar = 150 μm.

?*Umbonula* sp.
Langhian, TF56, 'Badak South', Samarinda.
Fig. 2. NHMUK PI BZ 6922. a, general view of the colony; scale bar = 500 μm. b, group of autozooids; scale bar = 200 μm. c, autozooid; scale bar = 100 μm.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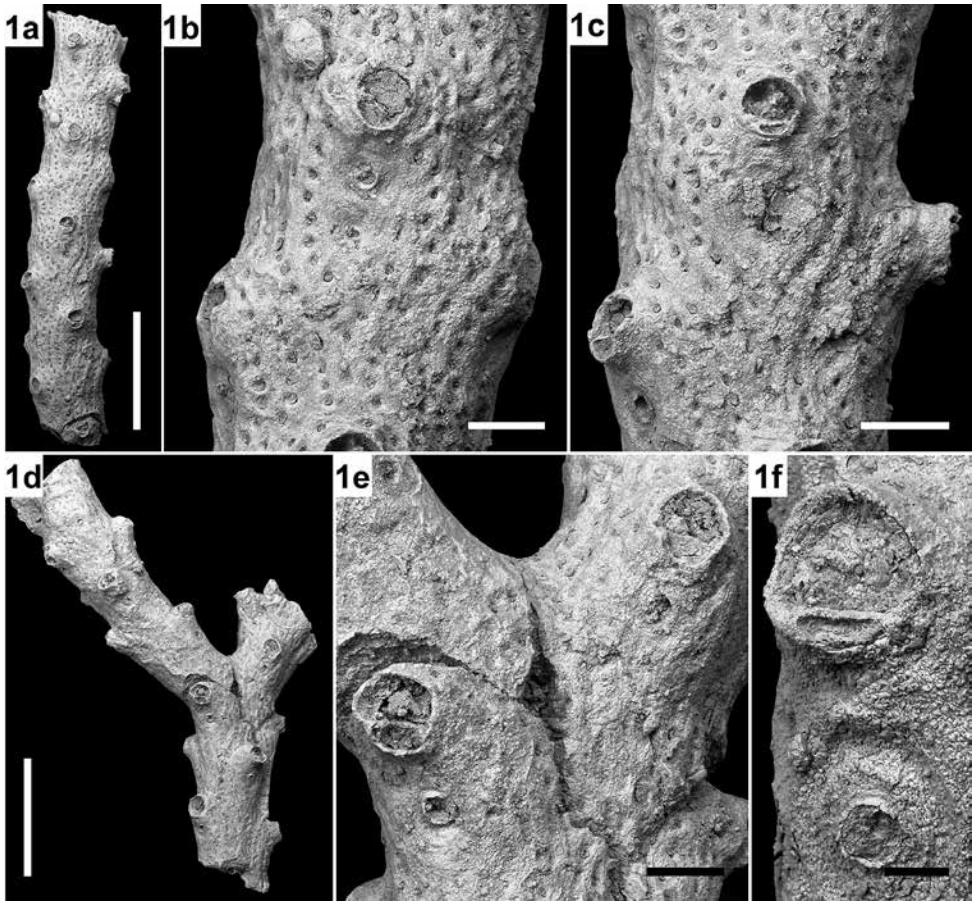


Plate 17

Sendinopora prima gen. et sp. nov.
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. a-c, Holotype: NHMUK PI BZ 6998. a, branch fragment; scale bar = 1 mm. b, autozooid with a rimmed ascopore; scale bar = 200 μm. c, autozooid with suboral avicularium; scale bar = 200 μm. d-e, Paratype: NHMUK PI BZ 6999. d, dichomotously branched fragment; scale bar = 1 mm. e, two autozooids at a bifurcation; scale bar = 150 μm. f, Paratype: NHMUK PI BZ 7000, orifice, suboral avicularium and ascopore; scale bar = 50 μm.

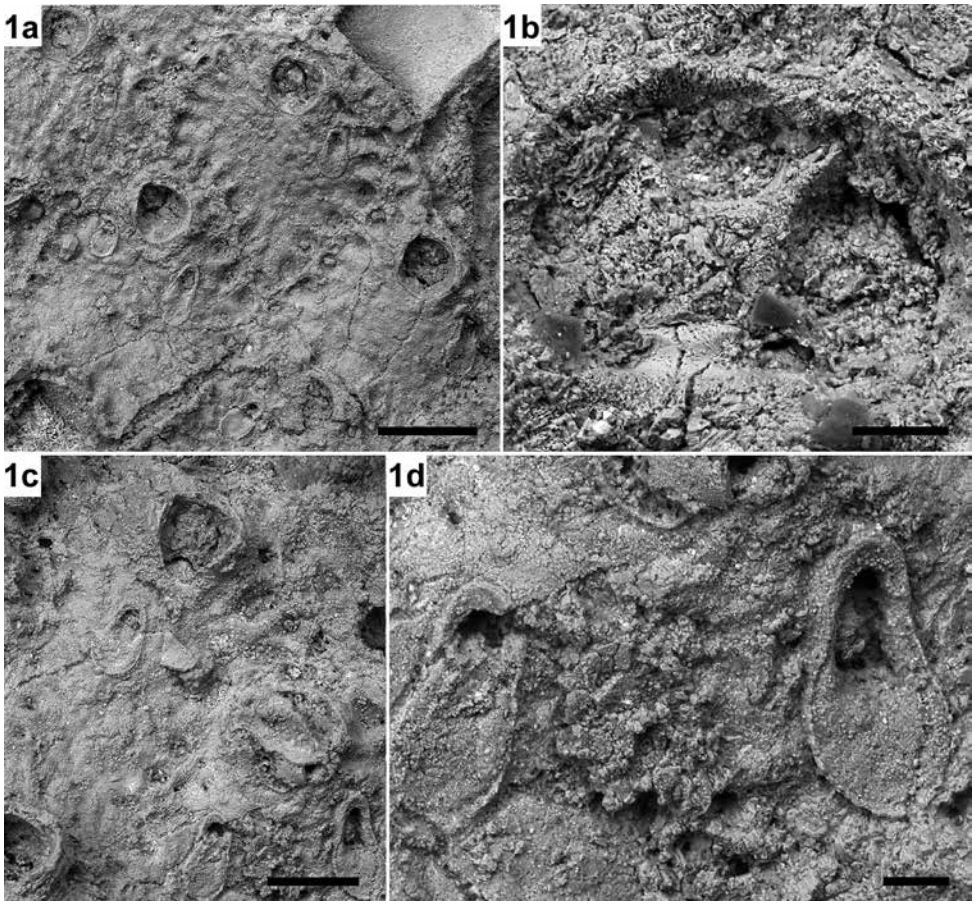


Plate 18

Parasmittina sp.
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. NHMUK PI BZ 6923. a, group of autozooids; scale bar = 200 μm. b, orifice and lyrula; scale bar = 20 μm. c, autozooid; scale bar = 100 μm. d, frontal, adventitious avicularia; scale bar = 20 μm.

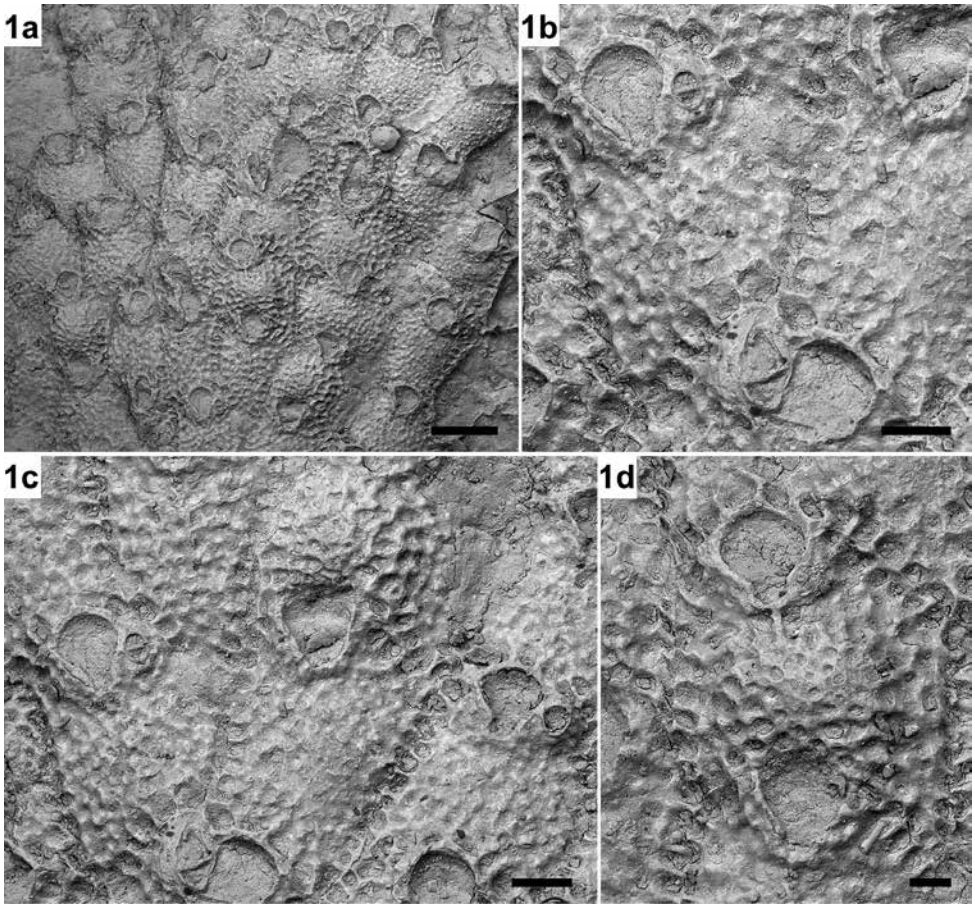


Plate 19

?*Pleurocodonellina* sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6924. a, view of part of the colony; scale bar = 500 μm. b, autozooid and latero-oral avicularia; scale bar = 200 μm. c, three zooids, one of which ovicellate; scale bar = 200 μm. d, ooecium; scale bar = 100 μm.

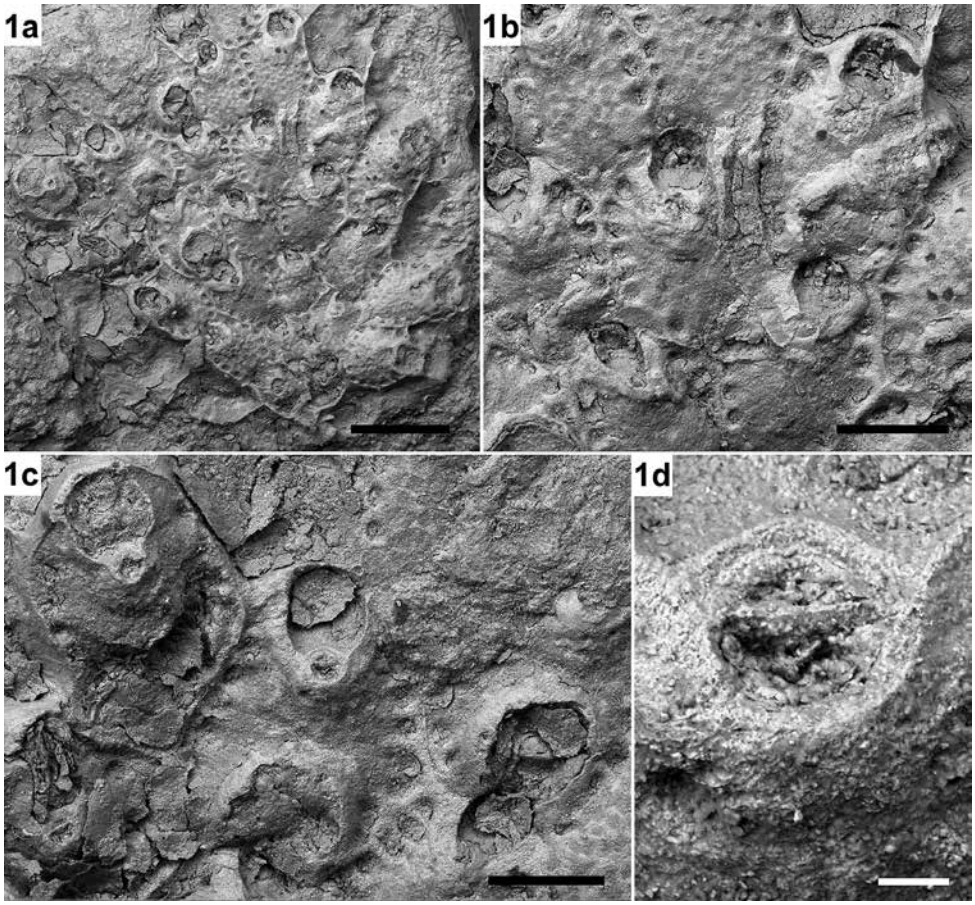


Plate 20

Smittina sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6925. a, part of the colony; scale bar = 500 μm. b, group of autozooids and ovicellate zooid; scale bar = 300 μm. c, group of autozooids showing two or three oral spine bases, suboral avicularia and an ooecium with crushed roof (bottom); scale bar = 150 μm. d, close-up of a suboral avicularium; scale bar = 20 μm.

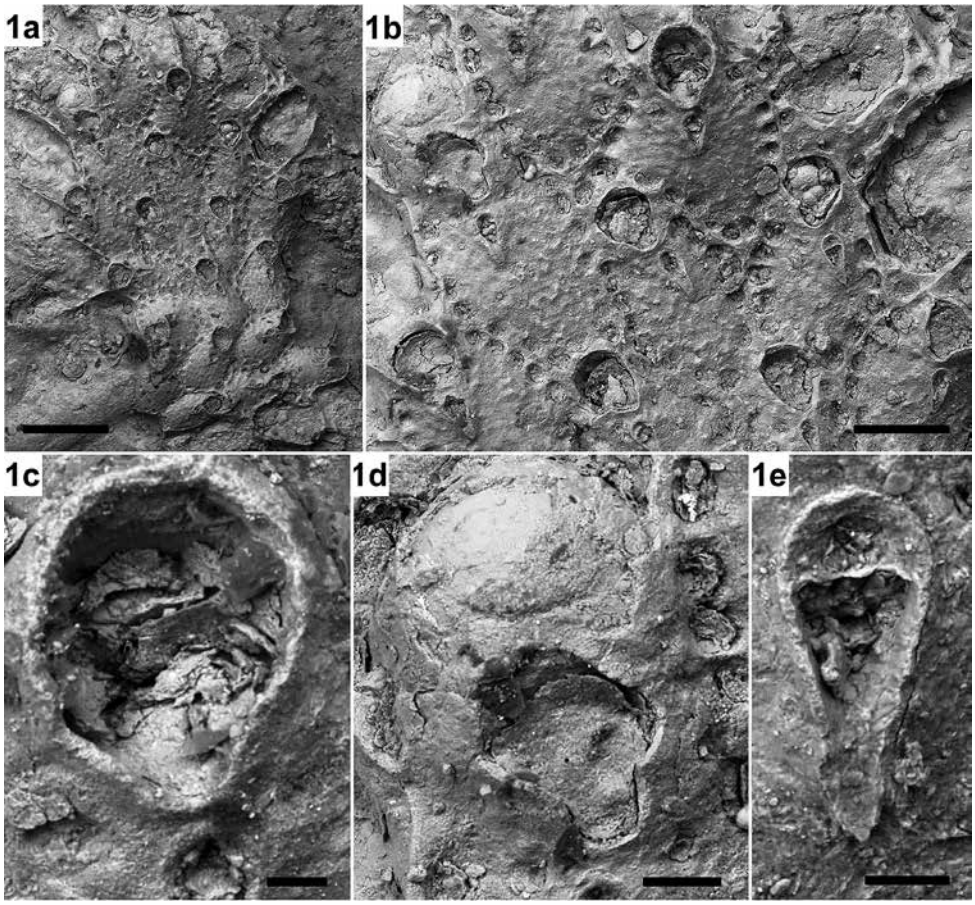
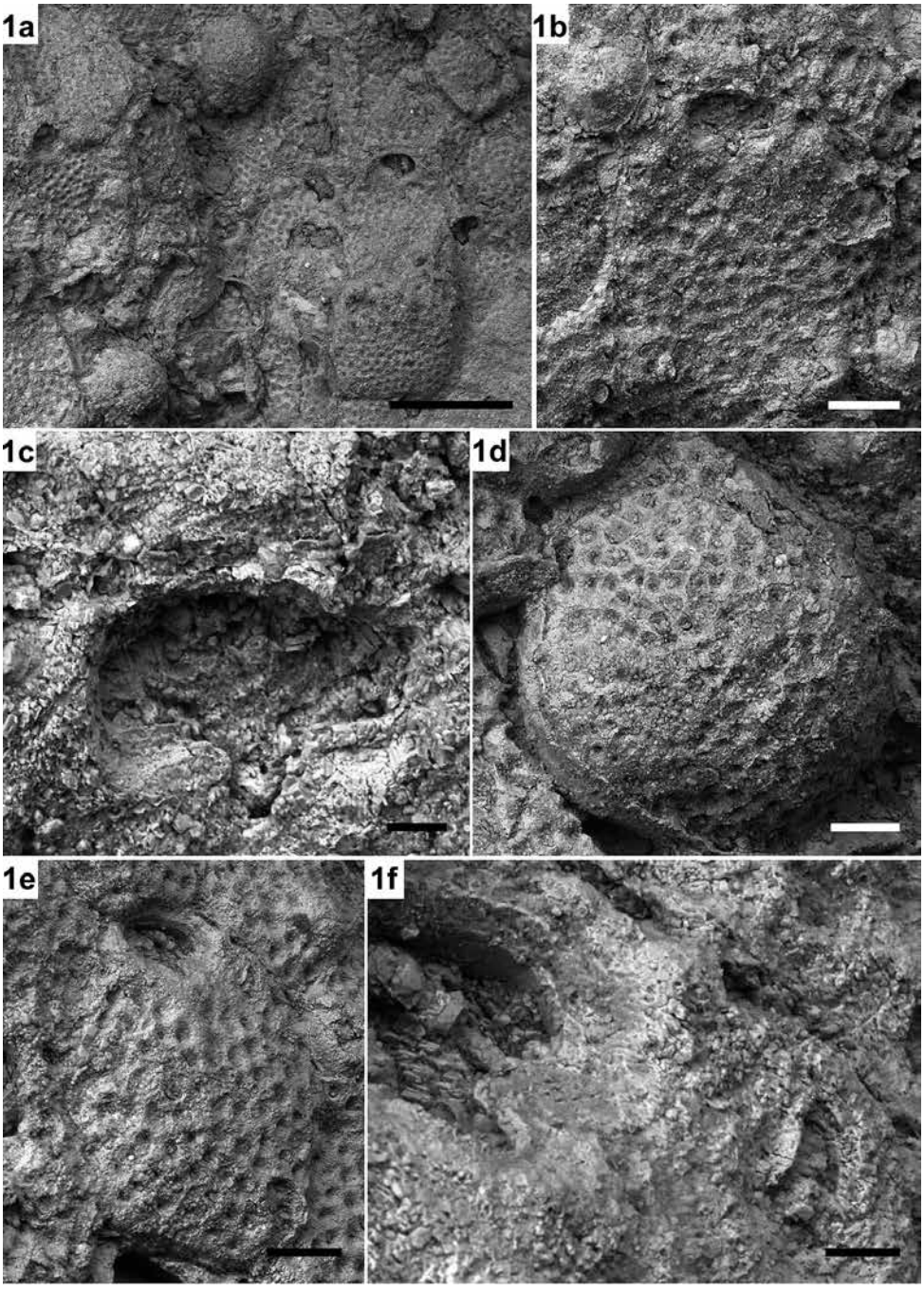


Plate 21

Smittoidea cf. *pacifica* Soule & Soule, 1973
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6926. a, part of the colony with ancestrula and early astogeny; scale bar = 500 μm. b, group of zooids one of which is ovicellate; scale bar = 200 μm. c, orifice with lyrula; scale bar = 20 μm. d, ooecium; scale bar = 50 μm. e, suboral avicularium; scale bar = 20 μm.

Plate 22 ▶

Stylopoma sp. 1
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6928. a, part of the colony; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c, orifice; scale bar = 20 μm. d, ooecium; scale bar = 50 μm. e, autozooid with latero-oral avicularium; scale bar = 100 μm. f, latero-oral avicularium; scale bar = 20 μm.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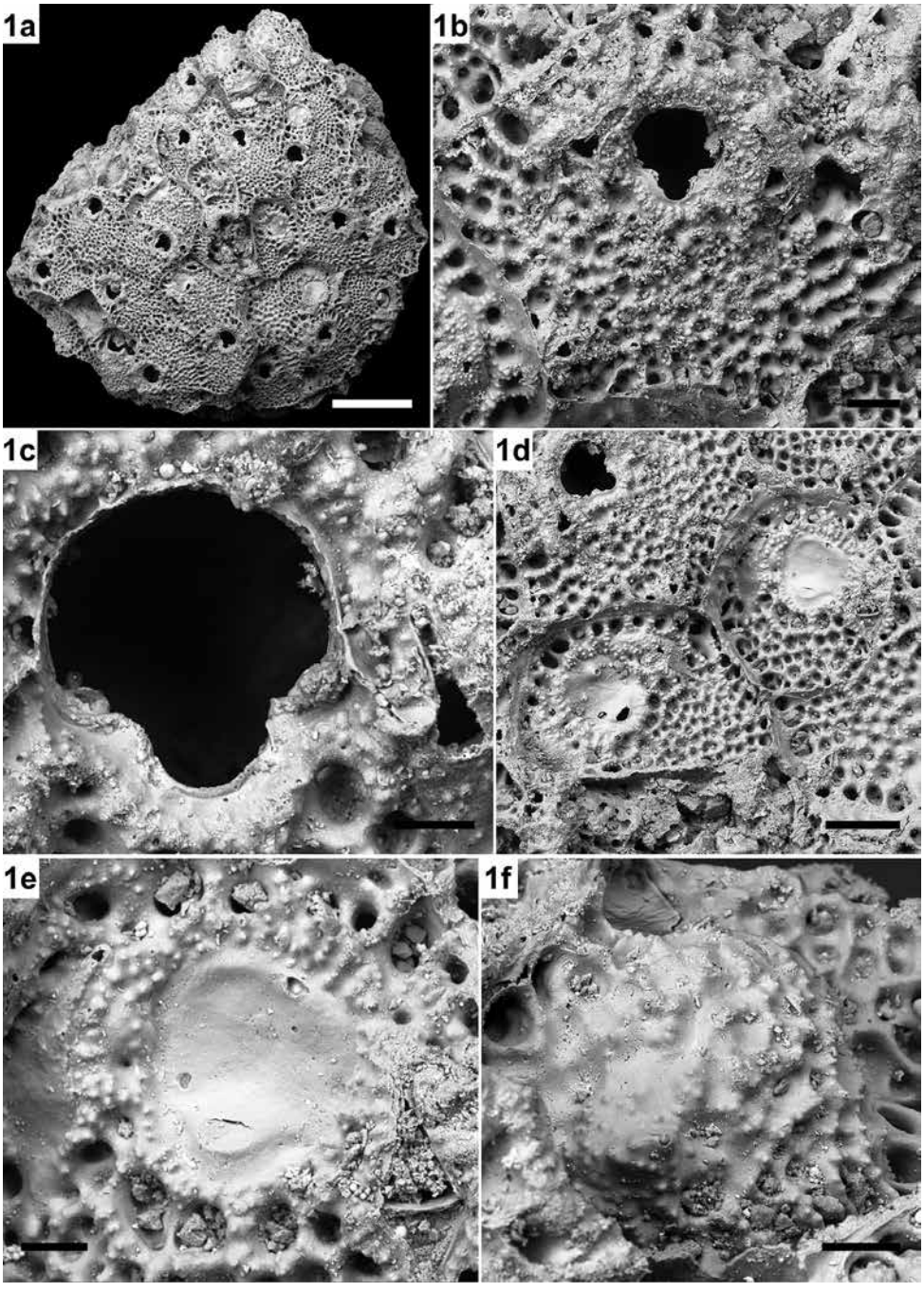
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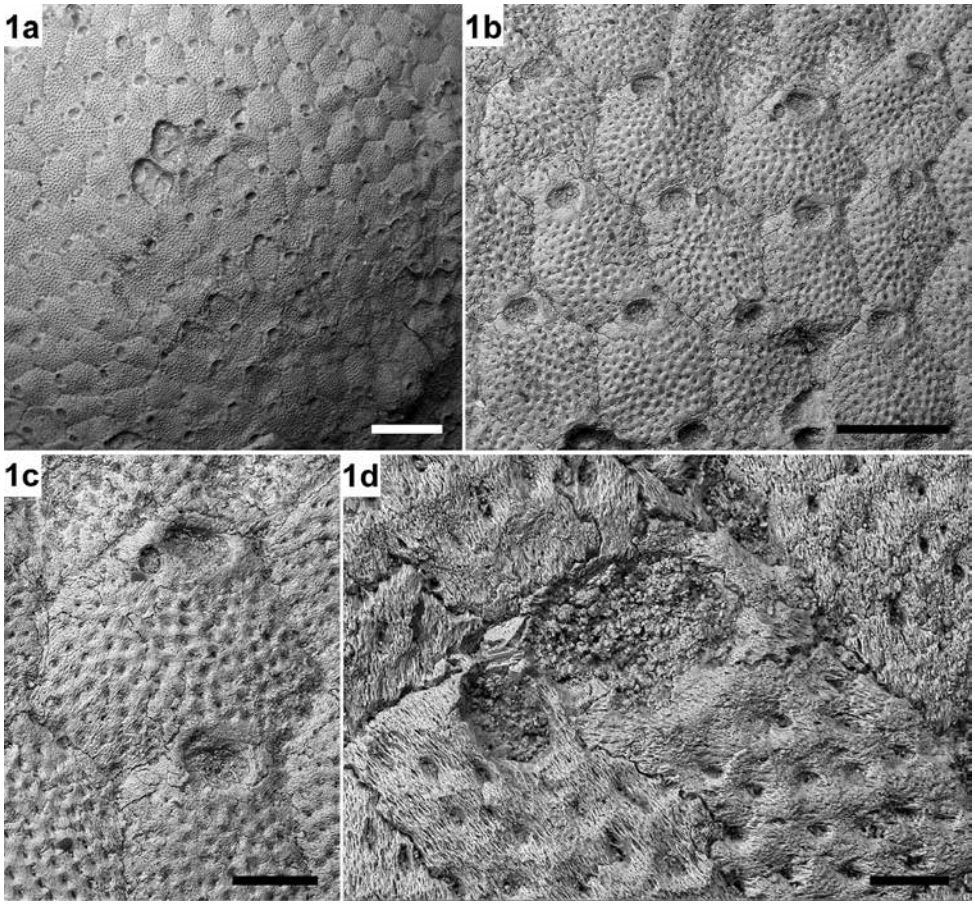


Plate 24

Stylopoma sp. 3
Messinian, TF511, 'Sekarat Top Reef', Sangkulirang.
Fig. 1. NHMUK PI BZ 6930. a, view of the colony; scale bar = 1 mm. b, group of autozooids; scale bar = 500 μm. c, autozooid with latero-oral avicularium; scale bar = 150 μm. d, orifice with latero-oral avicularium; scale bar = 50 μm.

◀ **Plate 23**

Stylopoma sp. 2
Early Tortonian, TF508, Bontang.
Fig. 1. NHMUK PI BZ 6929. a, view of the colony; scale bar = 1 mm. b, autozooid; scale bar = 100 μm. c, orifice; scale bar = 50 μm. d, two autozooids with closure plates; scale bar = 200 μm. e, orifice with closure plate and lozenge-shaped, latero-oral avicularium; scale bar = 50 μm. f, ooecium; scale bar = 100 μm.

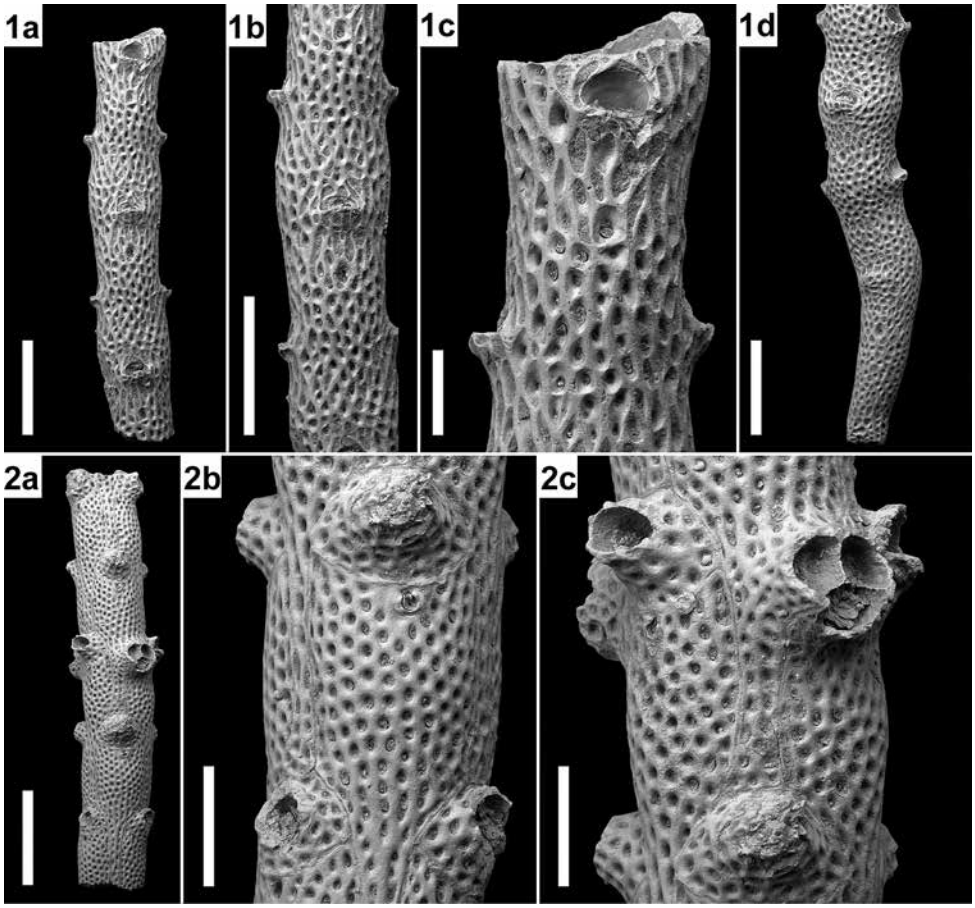


Plate 25

Margaretta aff. *gracilior* (Ortmann, 1892)
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, NHMUK PI BZ 6931. a, branch fragment; scale bar = 500 μm. b, autozooid with orifice immersed in the calcification; scale bar = 500 μm. c, autozooid with semicircular orifice; scale bar = 100 μm. d, NHMUK PI BZ 6932, fragment of a basal internode; scale bar = 500 μm.

Margaretta aff. *tenuis* Harmer, 1957
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 2. NHMUK PI BZ 6933. a, branch fragment; scale bar = 1 mm. b, autozooid; scale bar = 250 μm. c, close-up of an autozooid and tripartite articulation; scale bar = 250 μm.

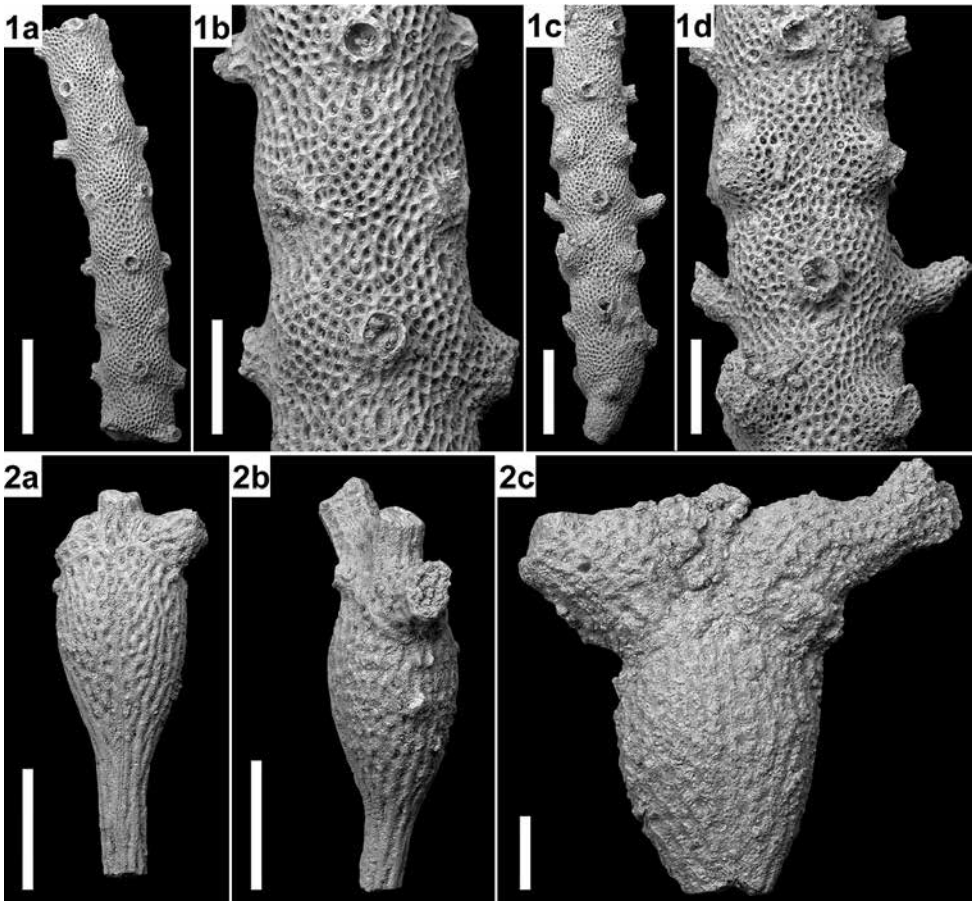


Plate 26

Margaretta aff. *watersi* (Canu & Bassler, 1930)
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. a-b, NHMUK PI BZ 6934. a, branch fragment; scale bar = 1.5 mm. b, autozooid; scale bar = 500 μm. c-d, NHMUK PI BZ 6935. c, branch fragment with basal articulation; scale bar = 1 mm. d, close-up of autozooids with swollen and longer peristomes; scale bar = 500 μm.

Margaretta amitabhae sp. nov.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 2. a-b, Holotype: NHMUK PI BZ 6937. a, lateral view of a disarticulated internode; scale bar = 500 μm. b, frontal view of a disarticulated internode; scale bar = 500 μm. c, Paratype: NHMUK PI BZ 6938, lateral view of a disarticulated internode with ?fertile zooid; scale bar = 200 μm.

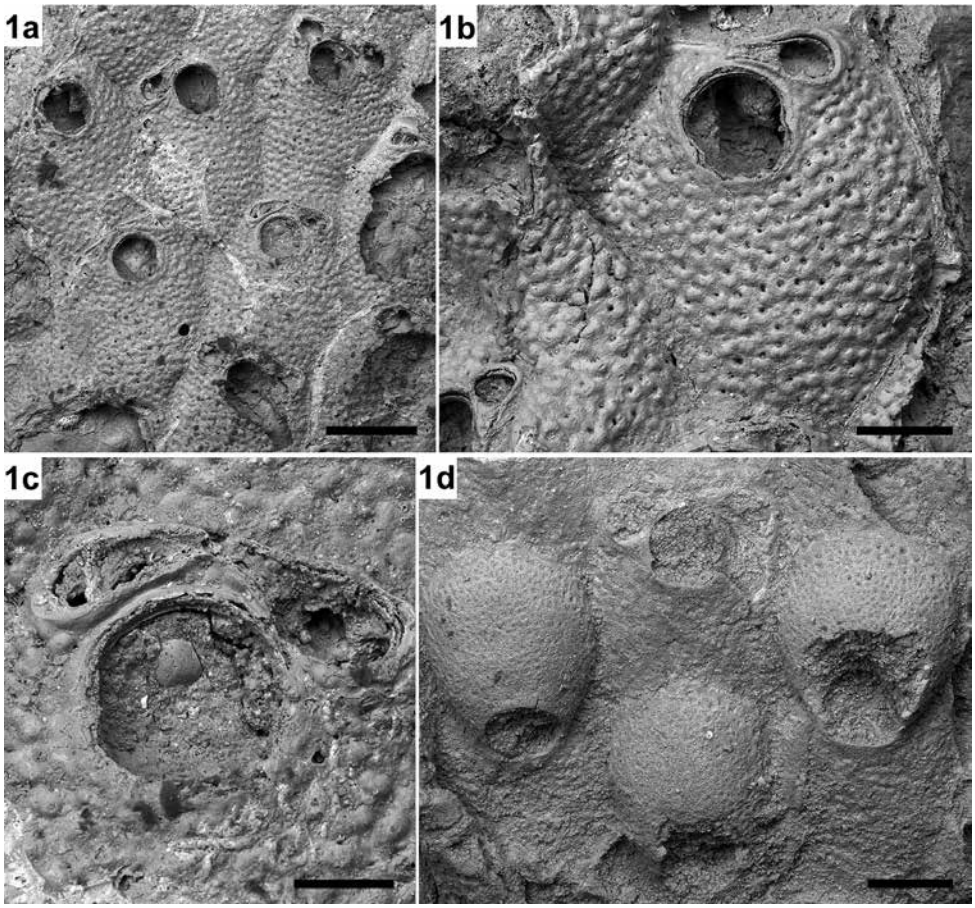


Plate 27

Hippopodina feegeensis (Busk, 1884)
Early Tortonian, TF508, Bontang.
Fig. 1. a-c, NHMUK PI BZ 6940. a, view of part of the colony; scale bar = 500 μm. b, autozooid; scale bar = 200 μm. c, orifice and paired distal avicularia; scale bar = 100 μm.

Serravallian, TF51, 'Stadio Reef 1', Samarinda.
Fig. 1. d, NHMUK PI BZ 6939, group of ovicellate zooids; scale bar = 200 μm.

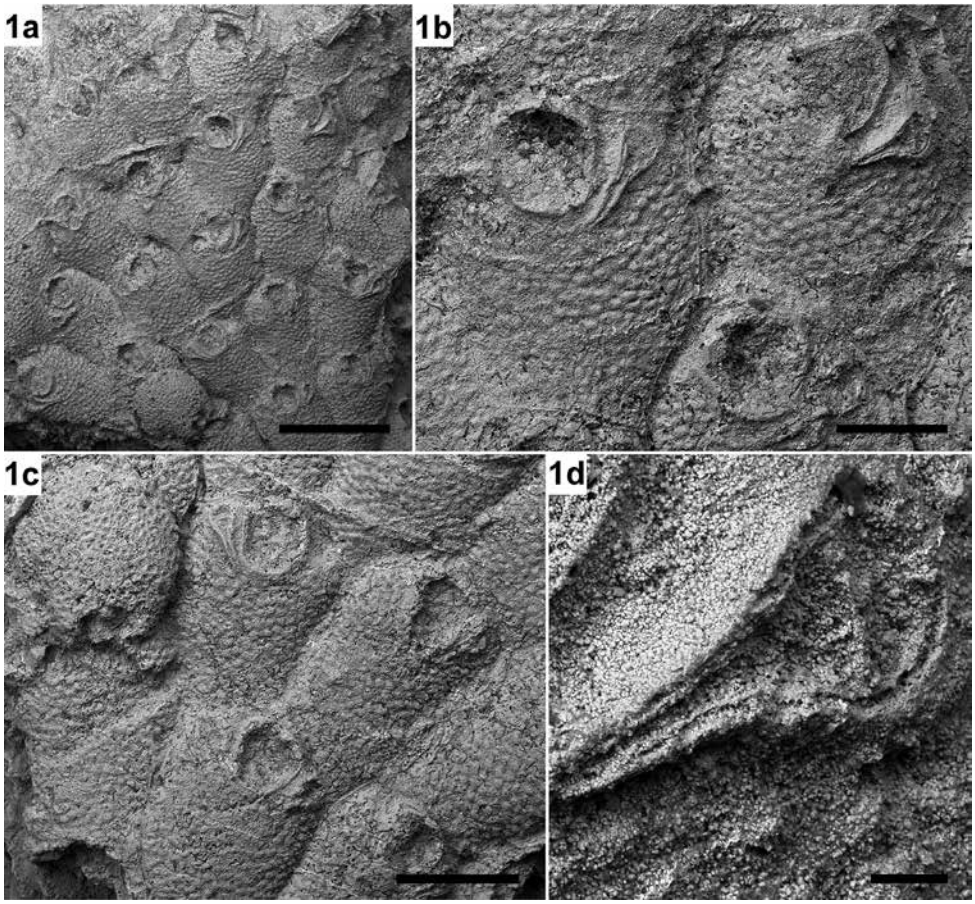


Plate 28

Hippopodina cf. *pulcherrima* (Canu & Bassler, 1928)
Messinian, TF511, 'Sekarat Top Reef', Sangkulirang.
Fig. 1. NHMUK PI BZ 6941. a, view of part of the colony; scale bar = 1 mm. b, two autozooids; scale bar = 300 μm. c, group of zooids, one of which is ovicellate; scale bar = 500 μm. d, avicularium; scale bar = 50 μm.

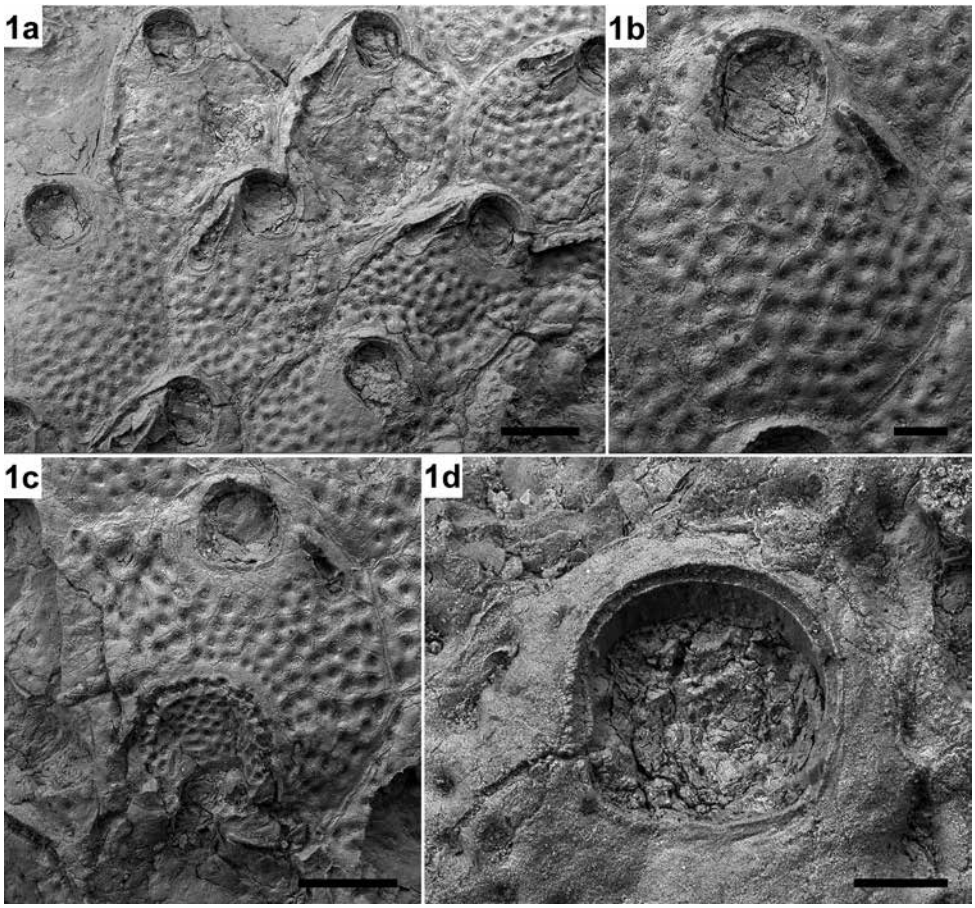


Plate 29

Hippopodina indicata sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6942. a, group of autozooids; scale bar = 300 μm. b, autozooid; scale bar = 150 μm. c, autozooid and broken ooecium; scale bar = 300 μm. d, orifice; scale bar = 100 μm.

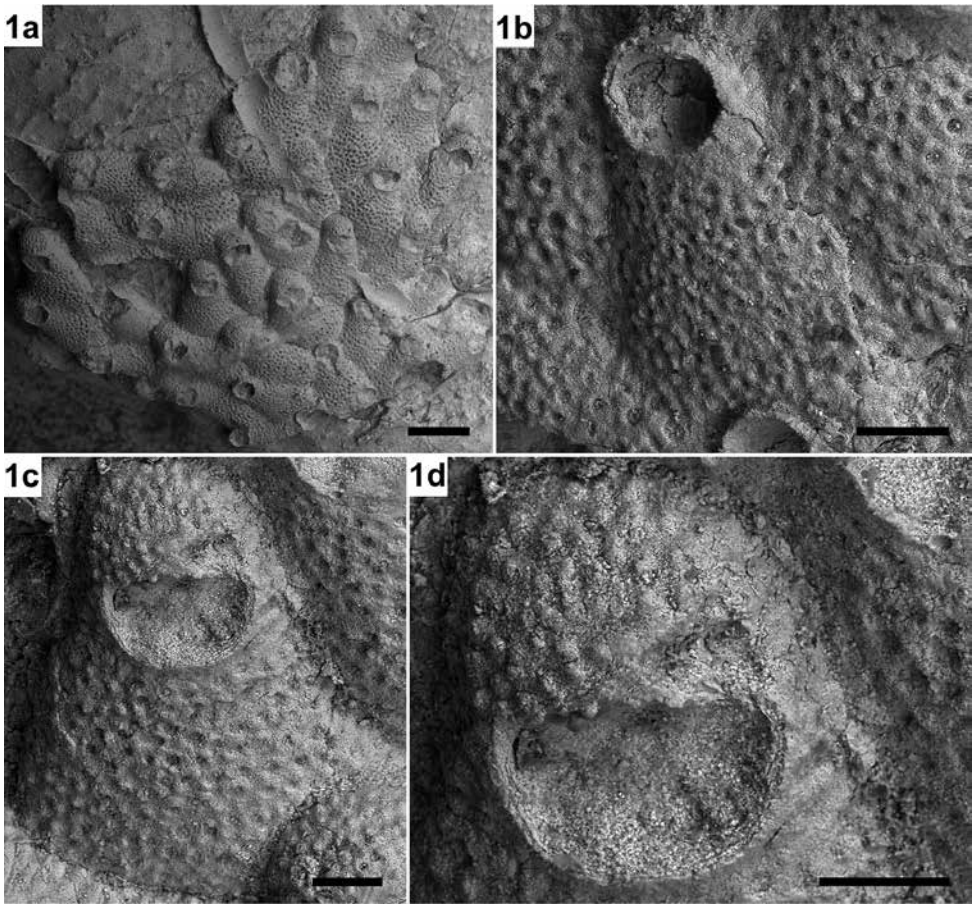


Plate 30

Saevitella renemai sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6943. a, view of part of the colony; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c, ovicellate zooid; scale bar = 100 μm. d, orifice and ooecium; scale bar = 100 μm.

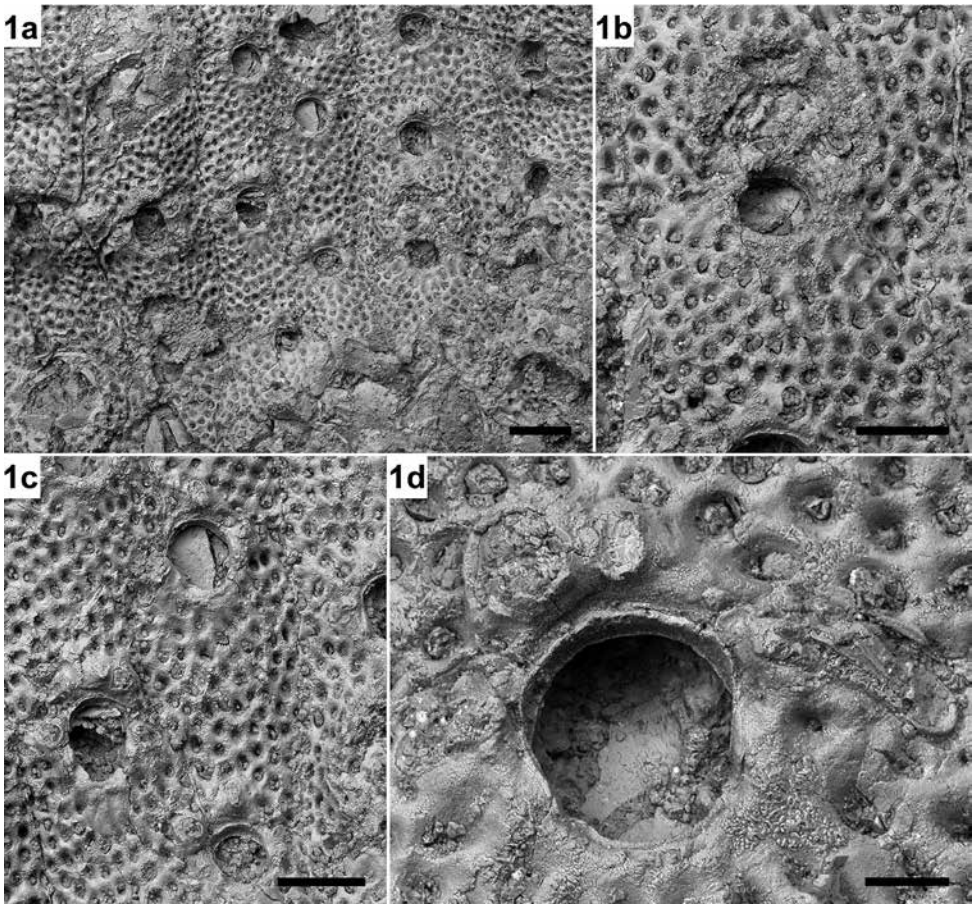


Plate 31

Thornelya sp.
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. NHMUK PI BZ 6944. a, view of part of the colony; scale bar = 250 μm. b, ovicellate zooid; scale bar = 150 μm. c, two autozooids with numerous adventitious avicularia; scale bar = 250 μm. d, orifice and disto-lateral avicularium; scale bar = 50 μm.

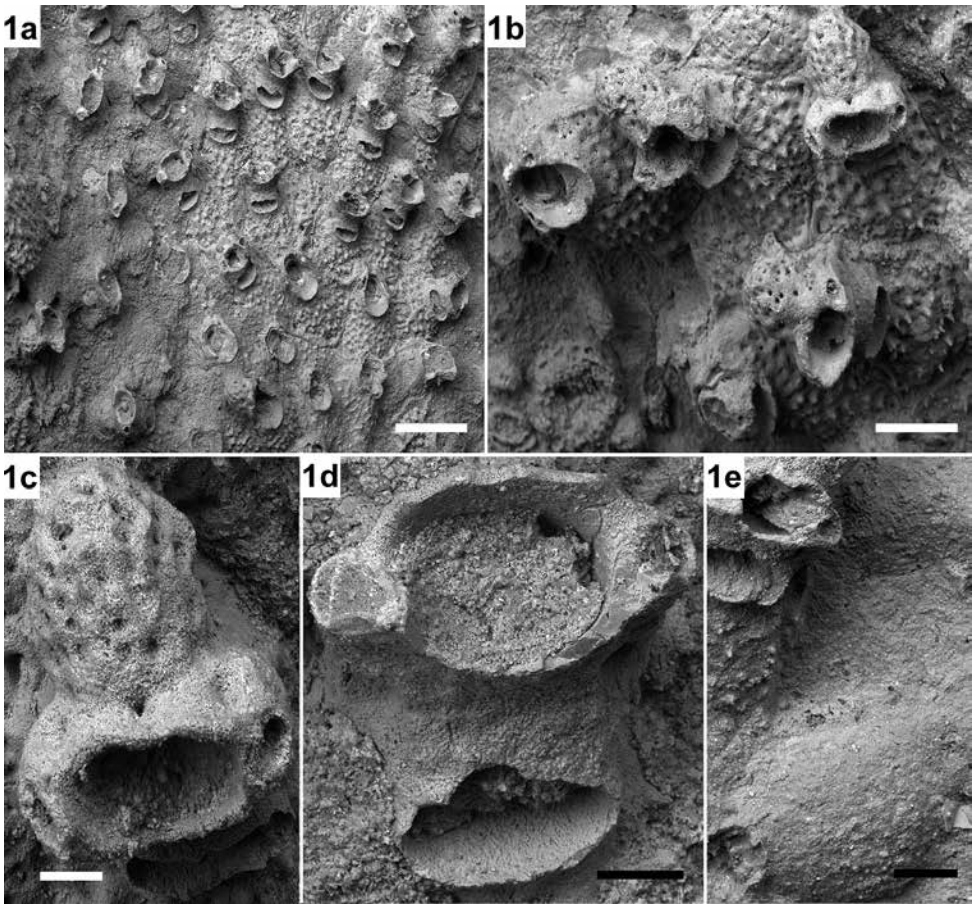


Plate 32

Gigantopora milenae sp. nov.
Serravallian, TF57, 'Stadion Reef 2', Samarinda.
Fig. 1. a-d, Holotype: NHMUK PI BZ 6945. a, view of the colony; scale bar = 500 μm. b, group of autozooids; scale bar = 200 μm. c, ooecium; scale bar = 50 μm. d, avicularia; scale bar = 50 μm.

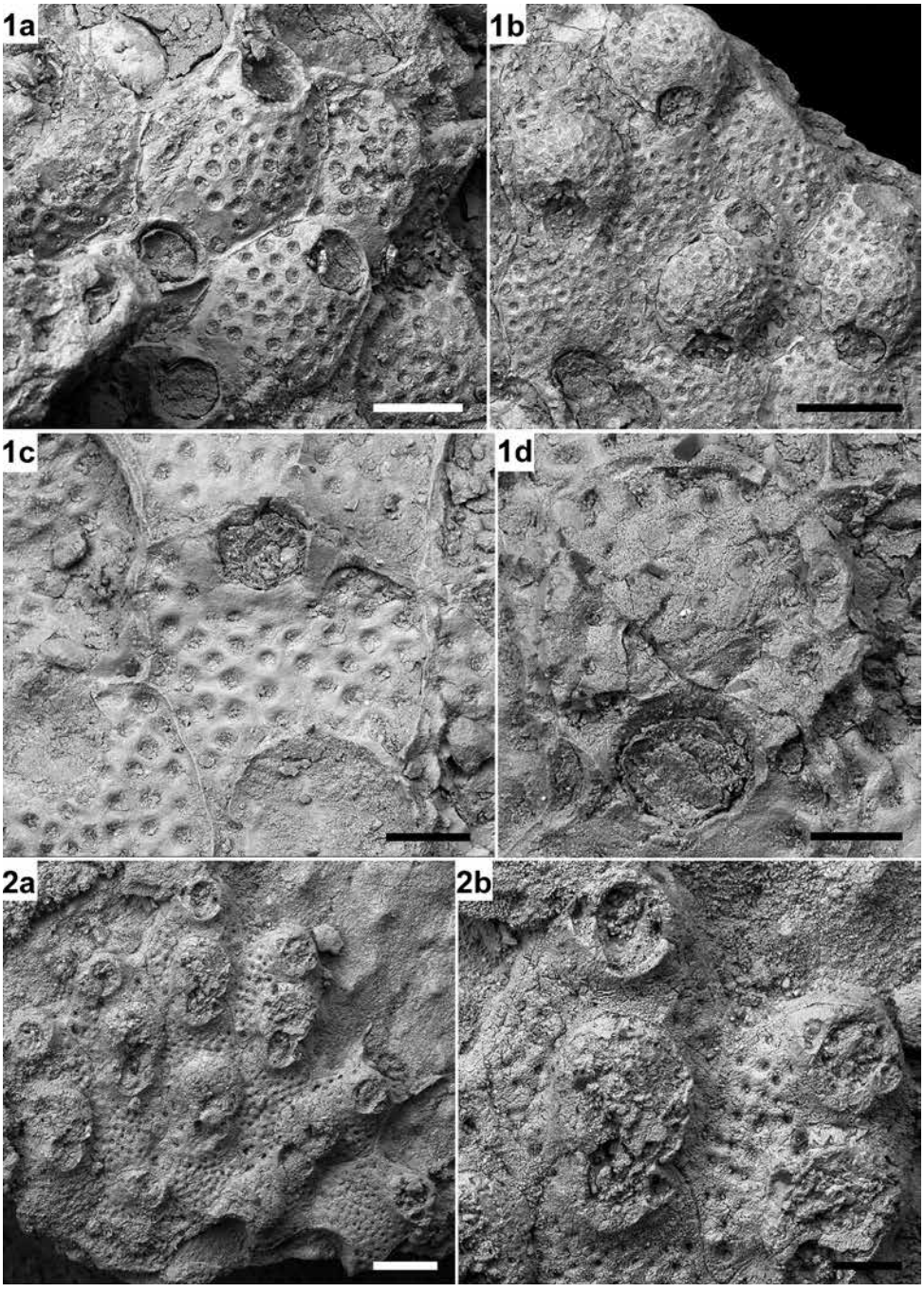
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. e, Paratype: NHMUK PI BZ 6946, ancestrula; scale bar = 100 μm.

Plate 33

Calyptotheca sp. 1
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. a-b, NHMUK PI BZ 6947. a, group of zooids; scale bar = 300 μm. b, group of ovicellate zooids; scale bar = 150 μm.

Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. c-d, NHMUK PI BZ 6948. c, autozooid; scale bar = 200 μm. d, orifice and broken ooecium; scale bar = 100 μm.

Calyptotheca sp. 2
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 2. NHMUK PI BZ 6949. a, view of the colony; scale bar = 250 μm. b, two autozooids and ooecium; scale bar = 100 μm.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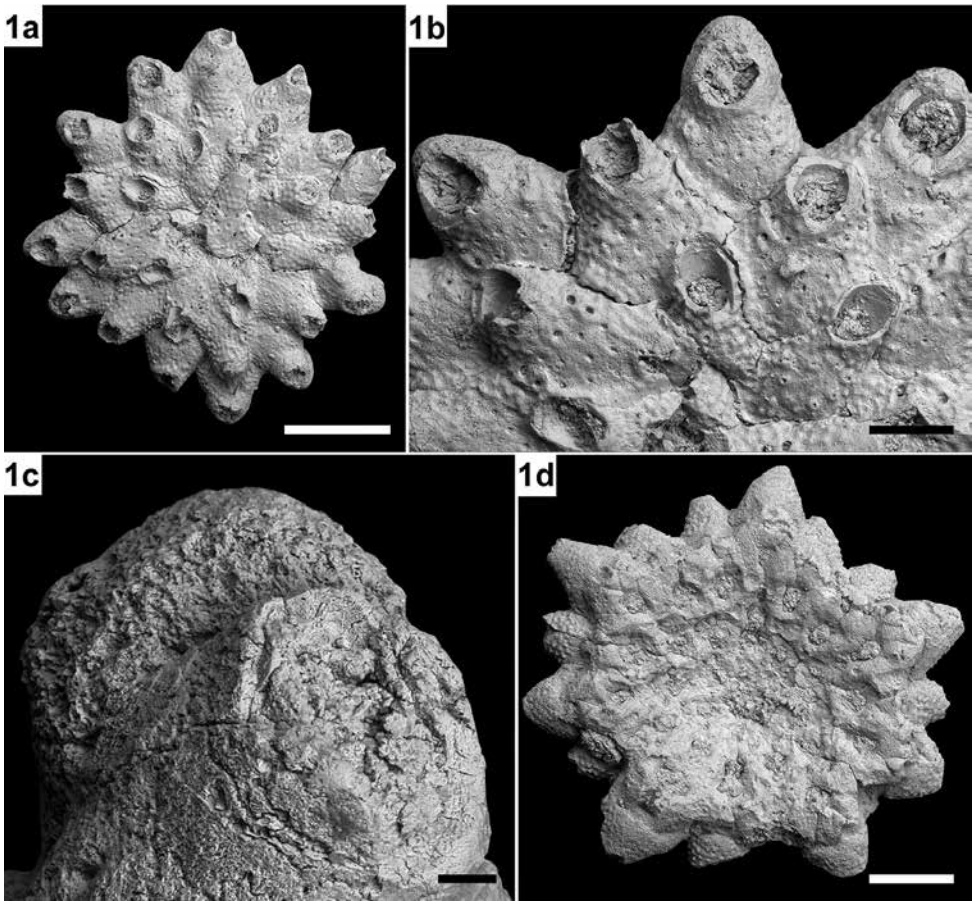


Plate 34

Actisecos sp. 1
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, NHMUK PI BZ 6950. a, view of the colony; scale bar = 500 μm. b, group of ovicellate and non-ovicellate zooids; scale bar = 200 μm. c, ooecium; scale bar = 20 μm. d, NHMUK PI BZ 6951, dorsal view of the colony; scale bar = 500 μm.

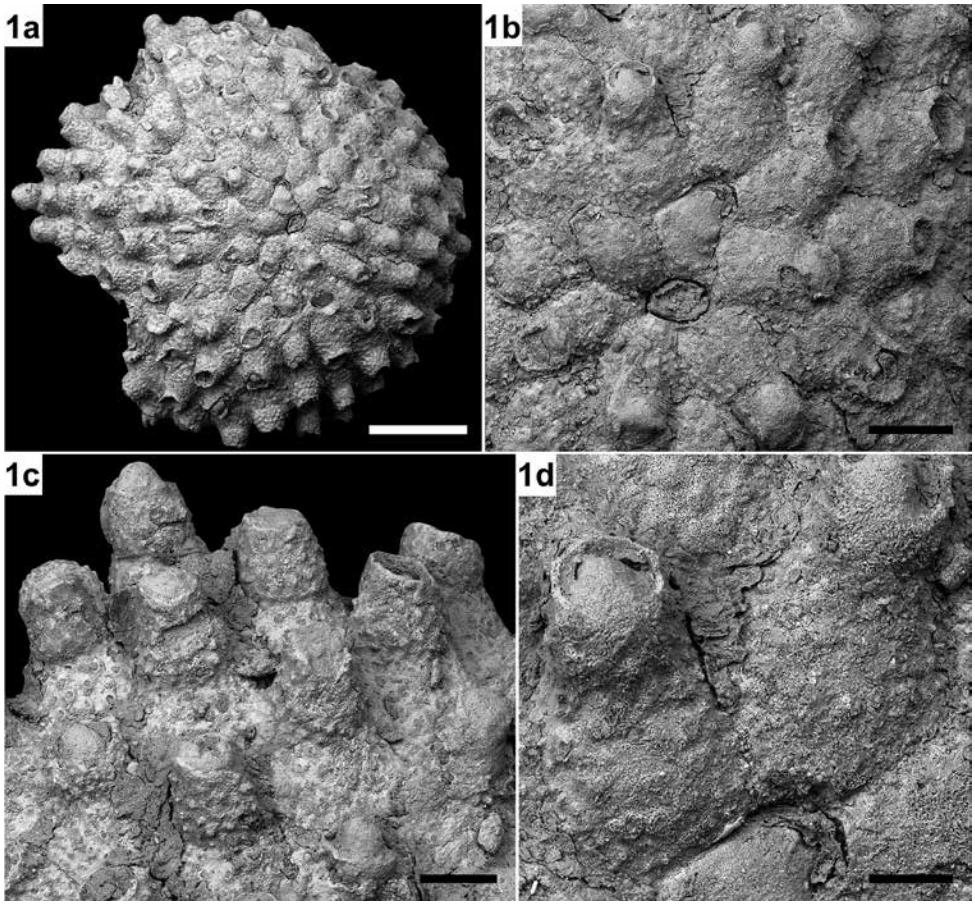


Plate 35

Actisecos sp. 2
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6952. a, view of the colony; scale bar = 1 mm. b, early astogeny; scale bar = 300 μm. c, group of ovicellate and non-ovicellate zooids; scale bar = 200 μm. d, two autozooids; scale bar = 100 μm.

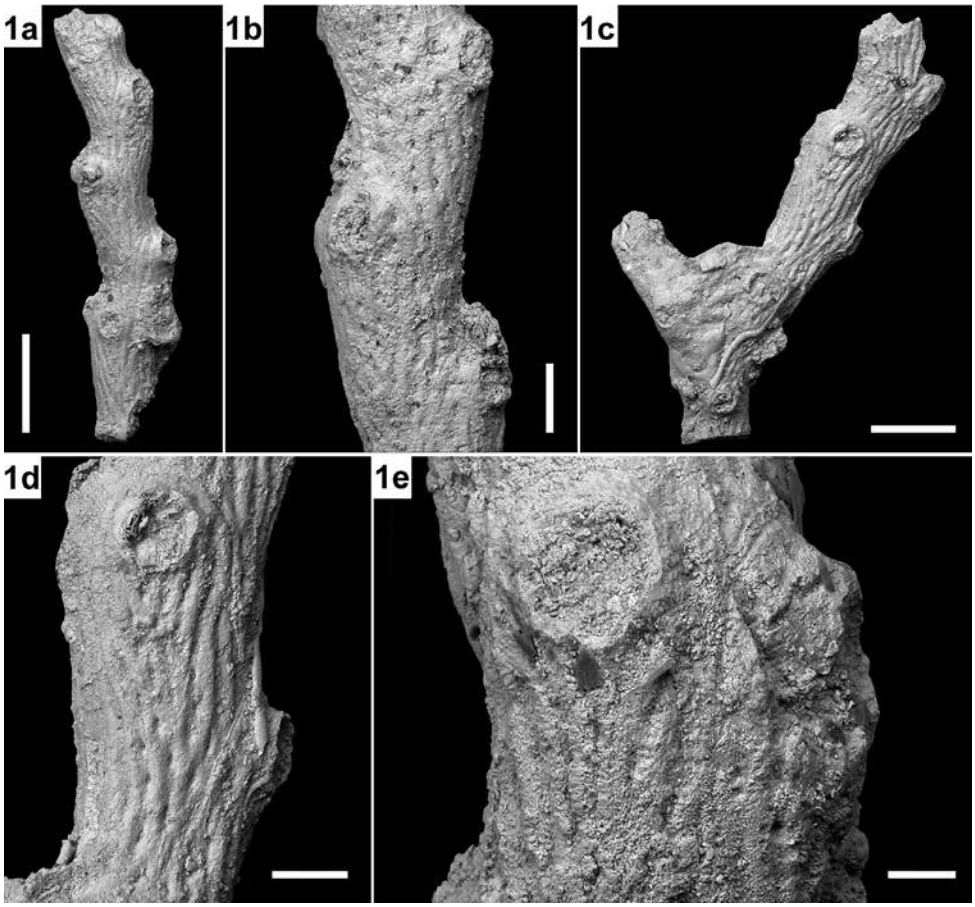


Plate 36

Vix sp.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. a-b, NHMUK PI BZ 6953. a, branch fragment; scale bar= 500 μm. b, two autozooids; scale bar= 150 μm. c-d, NHMUK PI BZ 6954. c, dichotomously branched fragment; scale bar= 300 μm. d, autozooid; scale bar= 100 μm. e, NHMUK PI BZ 6955, orifice; scale bar= 50 μm.

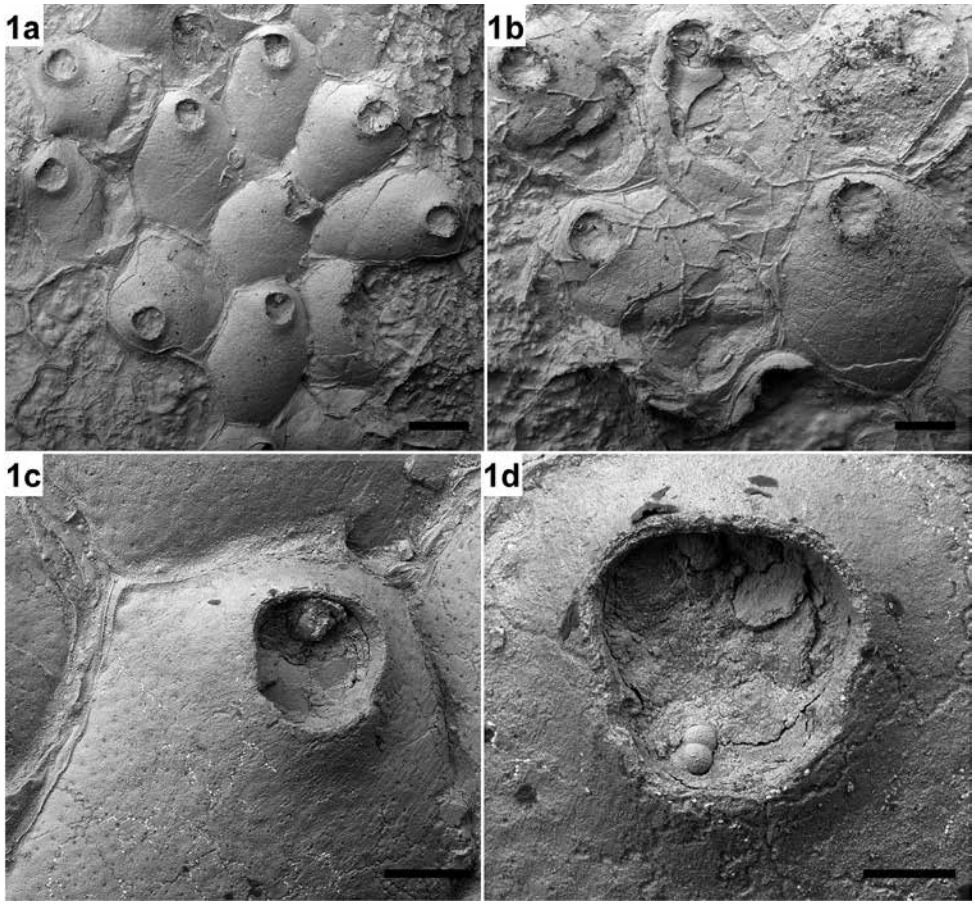


Plate 37

Orbiculipora sp.
Late Burdigalian, TF 126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6956. a, view of part of the colony; scale bar = 500 μm. b, group of autozooids; scale bar = 300 μm. c, minutely porous frontal shield; scale bar = 200 μm. d, orifice; scale bar = 100 μm.

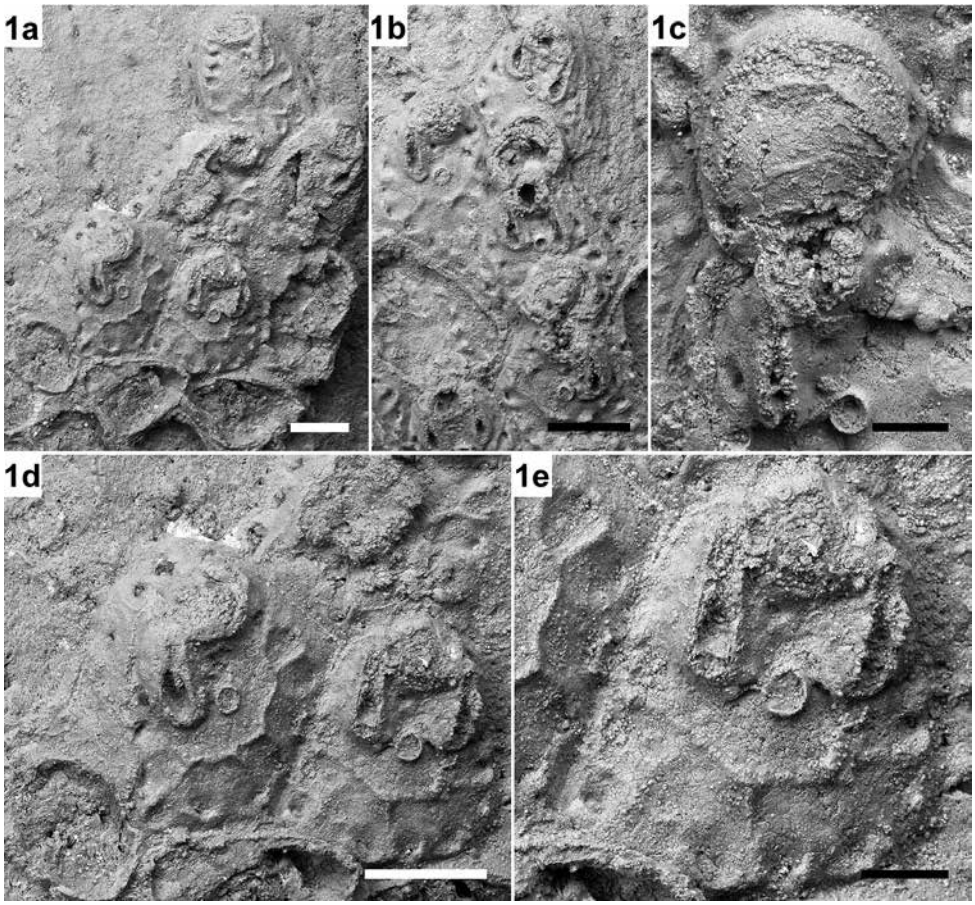


Plate 38

Calloporina sp.
Serravallian, TF 522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 1. NHMUK PI BZ 6958. a, view of part of the colony with poorly preserved ancestrula and early astogeny; scale bar = 200 μm. b, group of ovicellate and non-ovicellate zooids; scale bar = 300 μm. c, ooecium; scale bar = 100 μm. d, two autozooids; scale bar = 200 μm. d, autozooid with paired avicularia and raised ascopore; scale bar = 100 μm.

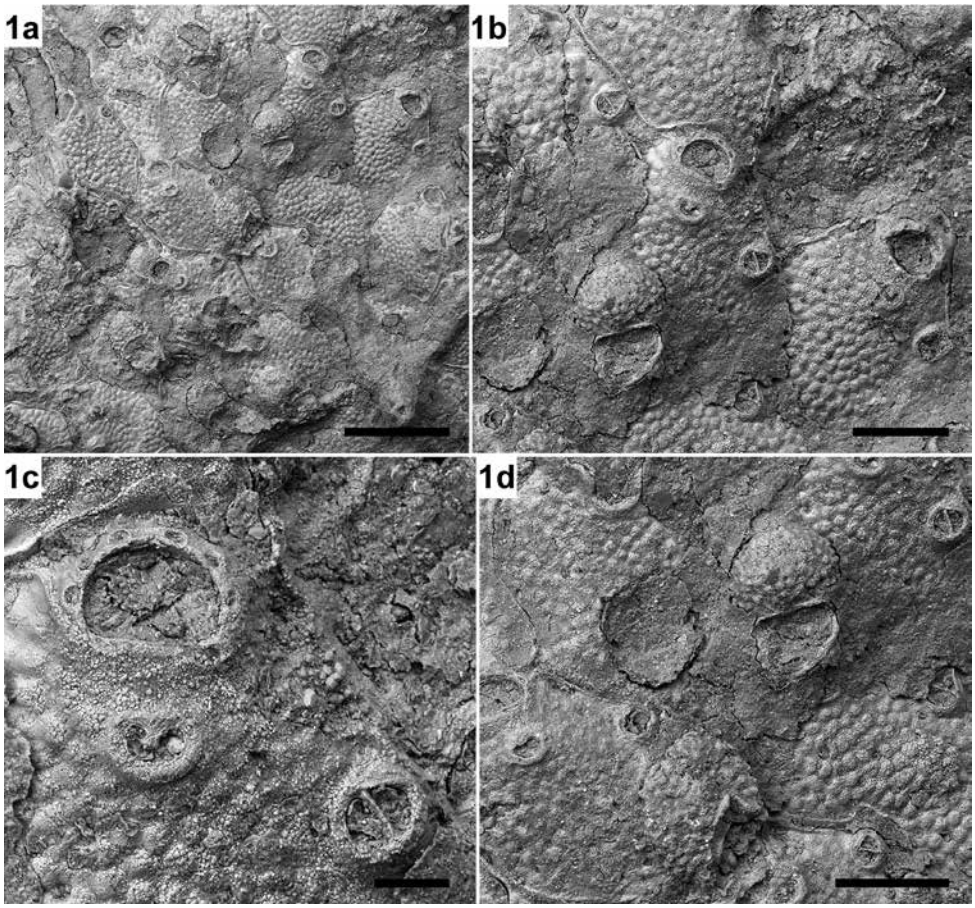


Plate 39

Microporella aff. *browni* Harmelin, Ostrovsky, Cáceres-Chamizo & Sanner, 2011
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK BZ 6957. a, view of the colony; scale bar = 500 μm. b, group of autozooids; scale bar = 200 μm. c, orifice with six oral spine bases, ascopore and adventitious avicularium; scale bar = 50 μm. d, zooids with 'personate' ooecia; scale bar = 200 μm.

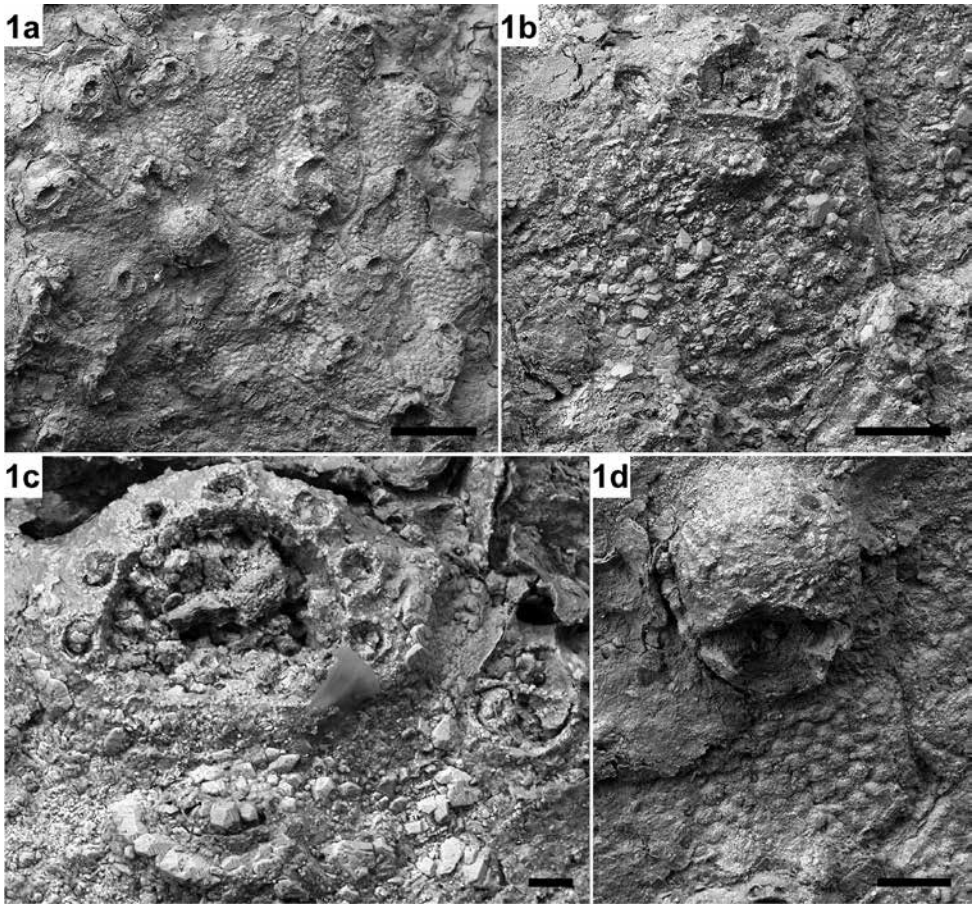


Plate 40

Microporella aff. *coronata* (Audouin, 1826)
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6959. a, view of the colony; scale bar = 500 μm. b, autozooid; scale bar = 100 μm. c, orifice with seven oral spine bases, ascopore and adventitious avicularium; scale bar = 20 μm. d, zooid with 'personate' ooecium; scale bar = 100 μm.

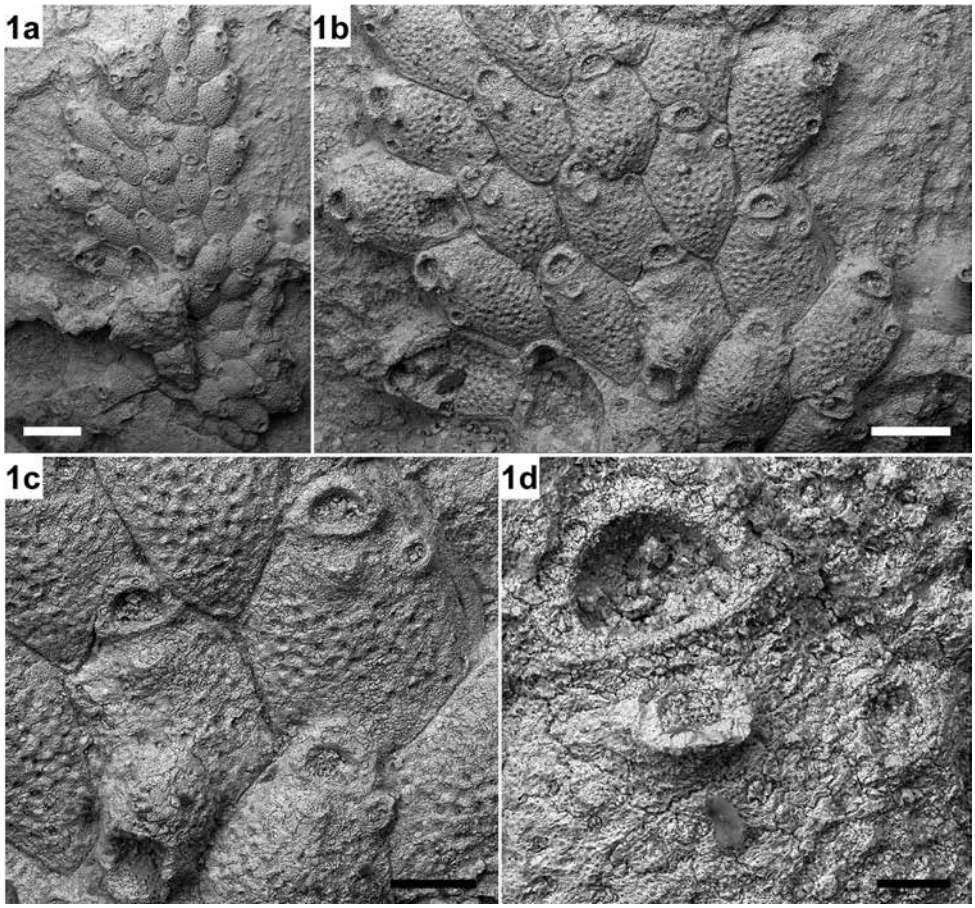


Plate 41

Microporella sp.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. NHMUK PI BZ 6960. a, view of the colony; scale bar = 500 μm. b, group of autozooids; scale bar = 300 μm. c, two autozooids and an ooecium (lower left); scale bar = 200 μm. d, orifice with eight oral spine bases, ascopore and adventitious avicularium; scale bar = 50 μm.

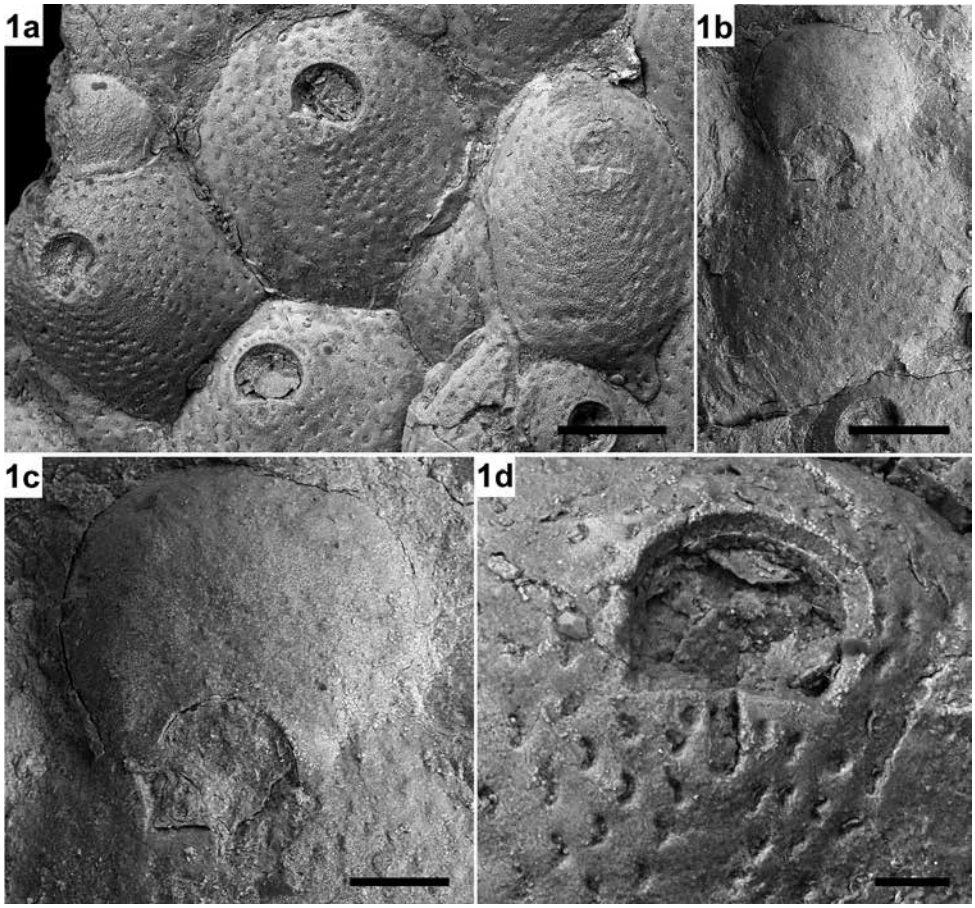


Plate 42

Arthropoma renipora sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, Holotype: NHMUK PI BZ 7002. a, group of autozooids; scale bar = 200 μm. b, ovicellate zooid; scale bar = 200 μm. c, orifice and ooecium; scale bar = 100 μm. d, Paratype: NHMUK PI BZ 6961, orifice; scale bar = 50 μm.

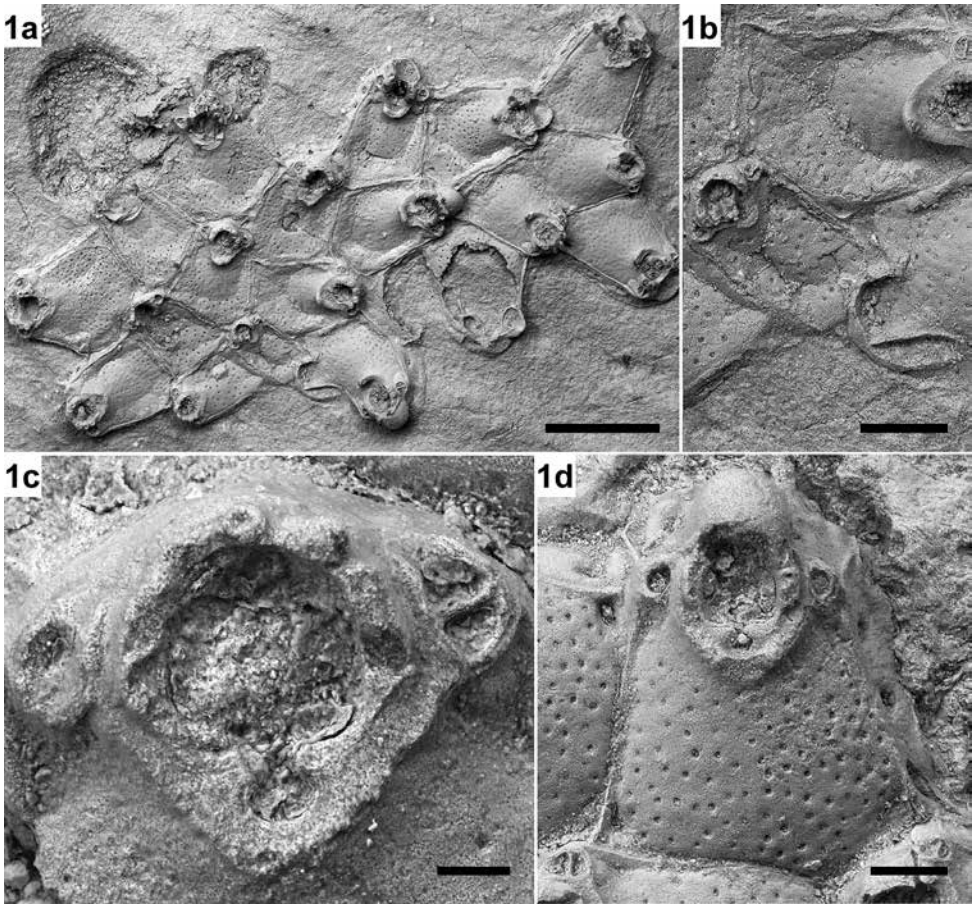


Plate 43

Bryopesanser bragai sp. nov.
Serravallian, TF59, 'Southern Hemisphere', Bontang.
Fig. 1. a-b, Holotype: NHMUK PI BZ 6962. a, view of the colony; scale bar = 500 μm. b, ancestrula and first budded zooid; scale bar = 150 μm. c, orifice and avicularium; scale bar = 50 μm. d, ovicellate zooid with basal pore chamber windows along the lateral margin; scale bar = 100 μm.

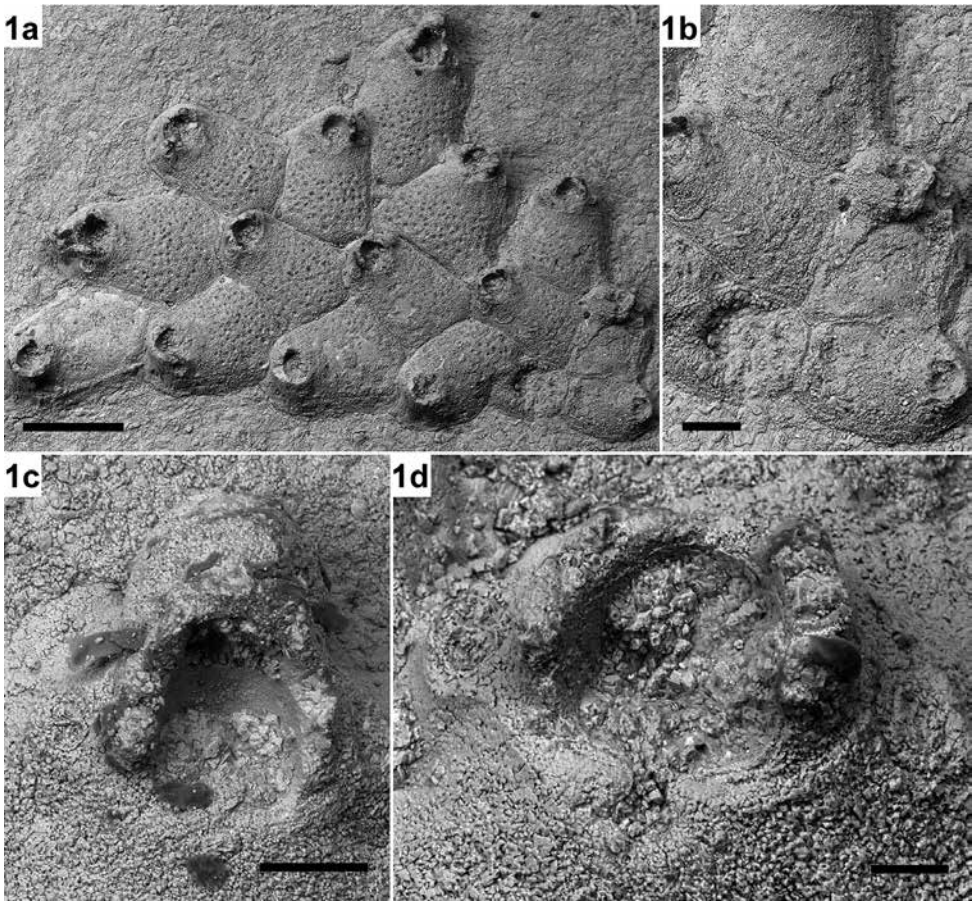


Plate 44

Bryopesanser sanfilippoae sp. nov.
Burdigalian-Langhian boundary, TF153, 'Rainy Section', Bontang.
Fig. 1. Holotype: NHMUK PI BZ 6963. a, view of the colony; scale bar = 300 μm. b, ancestrula and first budded zooid; scale bar = 100 μm. c, ooecium; scale bar = 50 μm. d, orifice; scale bar = 20 μm.

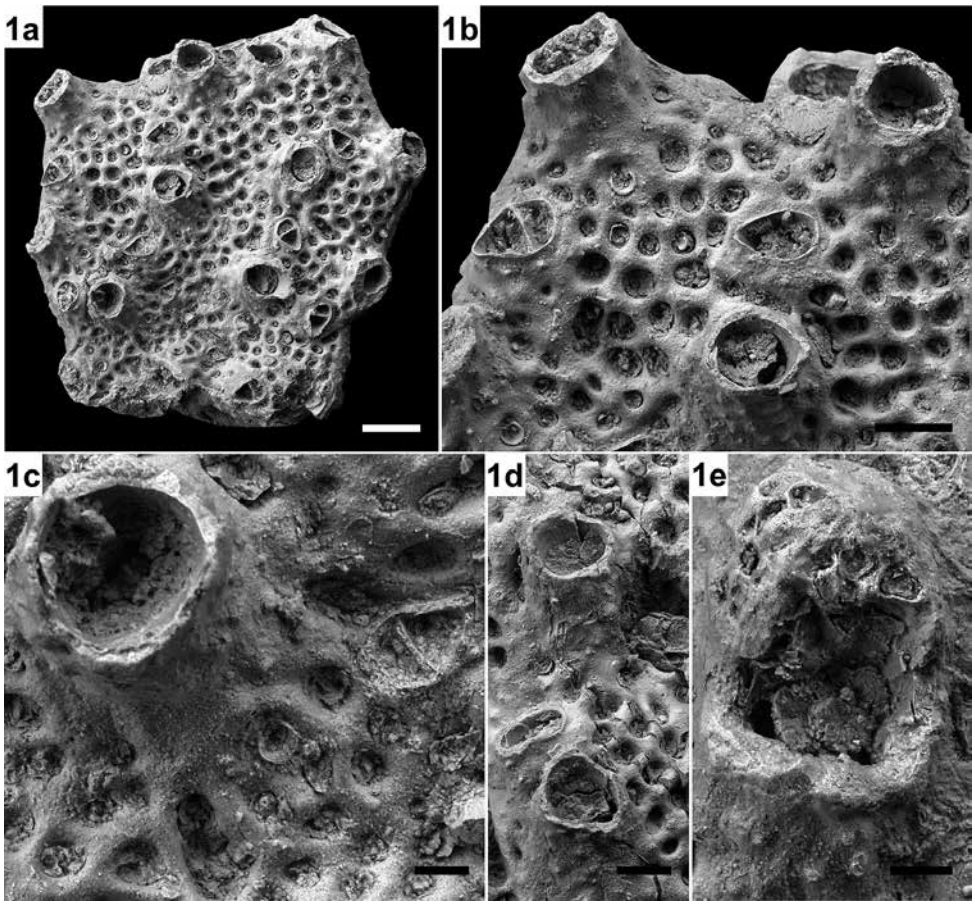
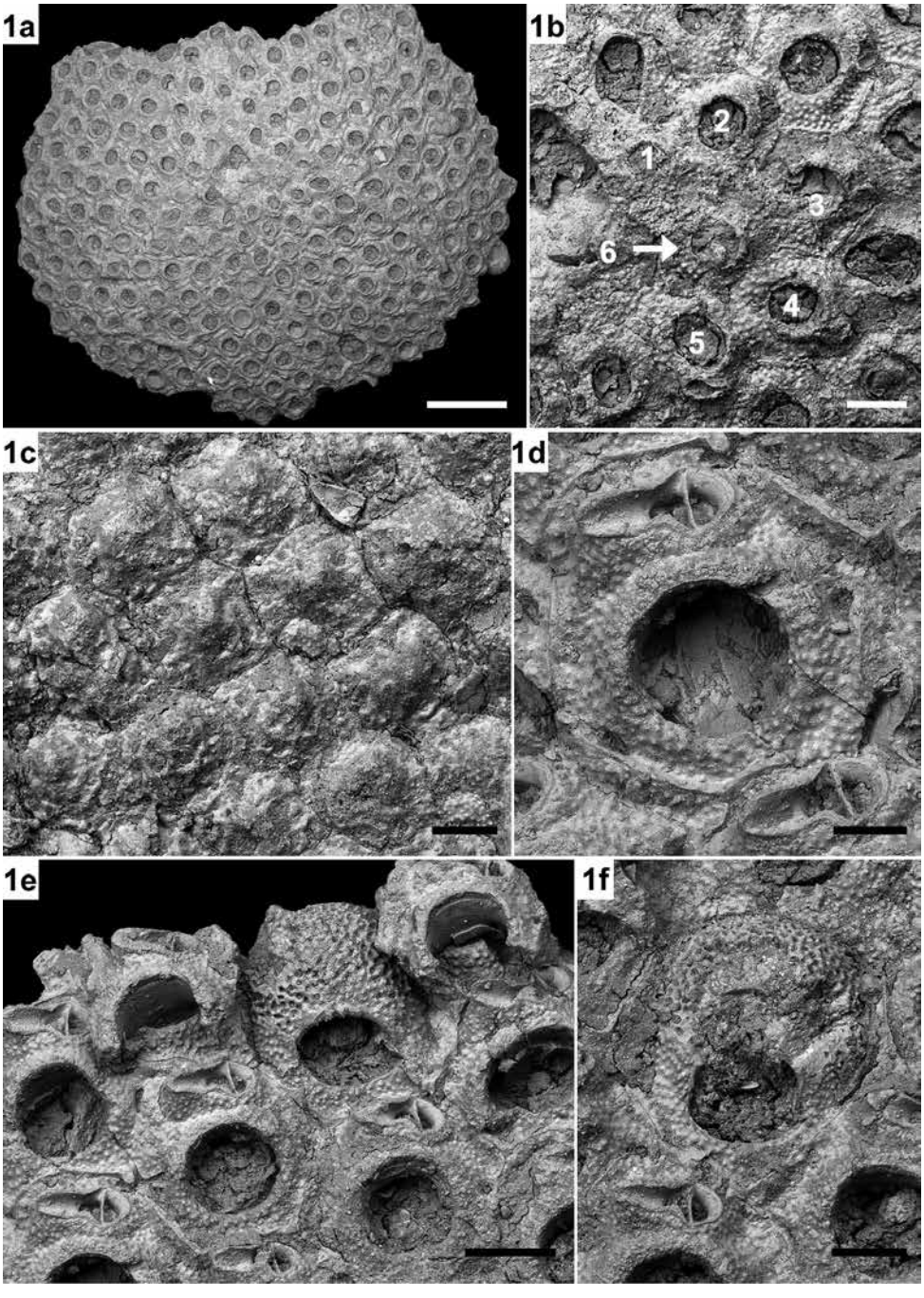


Plate 45

Tubiporella magnipora sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, Holotype: NHMUK PI BZ 6964. a, branch fragment; scale bar = 250 μm. b, two autozooids; scale bar = 200 μm. c, peristomial orifice, ascopore and smaller avicularium; scale bar = 50 μm. d, Paratype: NHMUK PI BZ 6965, orifices and an oval avicularium; scale bar = 150 μm. e, Paratype: NHMUK PI BZ 6966, orifice of zooid with an ooecium; scale bar = 50 μm.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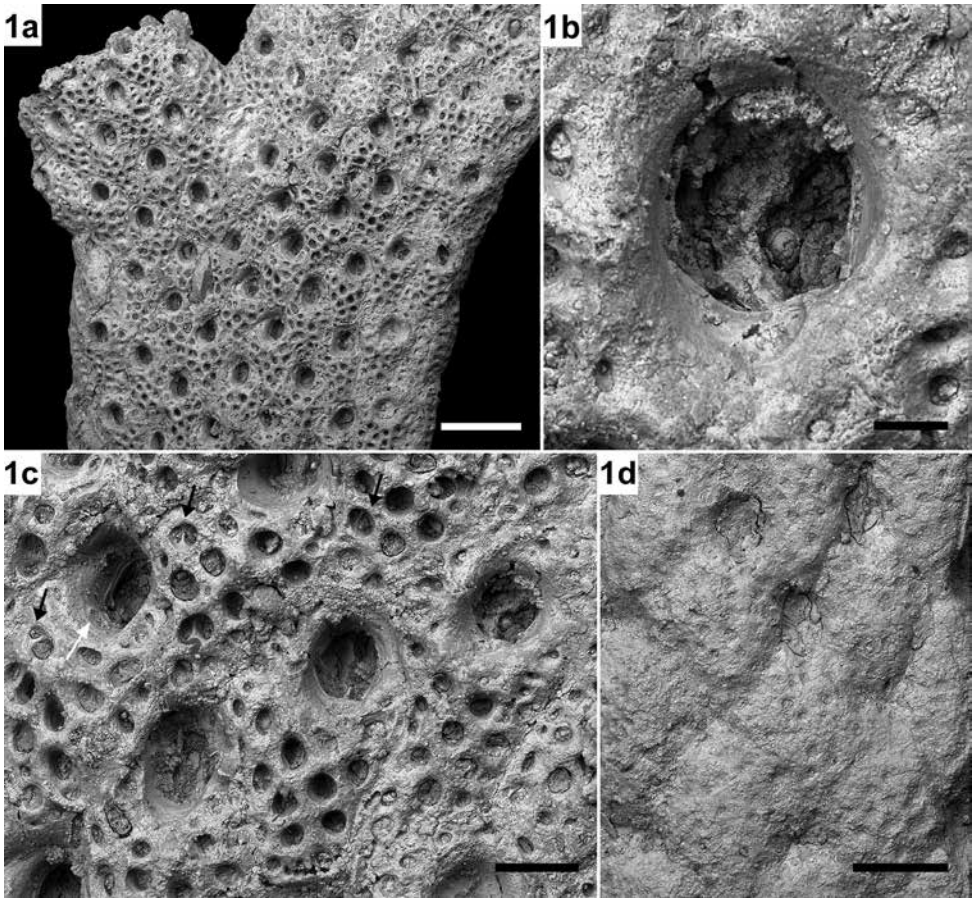


Plate 47

Cigclisula aff. *ramparensis* Guha & Gopikrishna, 2007
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. a-c, NHMUK PI BZ 6969. a, part of a branch fragment; scale bar = 500 μm. b, orifice; scale bar = 50 μm. c, group of autozooids with suboral avicularium on the peristomial shelf (white arrow) and frontal avicularia (black arrows); scale bar = 150 μm. d, NHMUK PI BZ 6970, group of autozooids with secondary calcification closing the apertures; scale bar = 200 μm.

◀ **Plate 46**

Anoteropora cf. *magnicapitata* Canu & Bassler, 1927
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. a-c, NHMUK PI BZ 6967. a, frontal view of a broken colony; scale bar = 1 mm. b, ancestrula and early astogeny; scale bar = 200 μm. c, dorsal side; scale bar = 200 μm. d-f, NHMUK PI BZ 6968. d, autozooid and distal avicularium; scale bar = 100 μm. e, group of ovicellate and non-ovicellate zooids; scale bar = 200 μm. f, ovicellate zooid; scale bar = 150 μm.

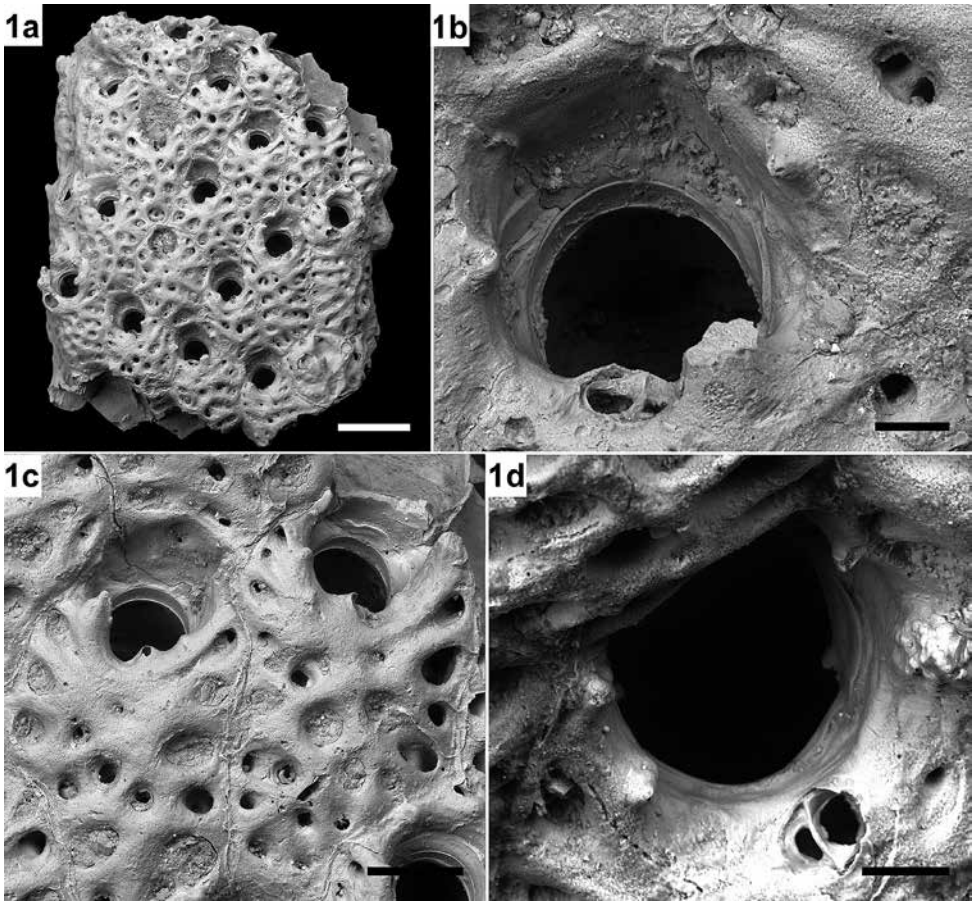
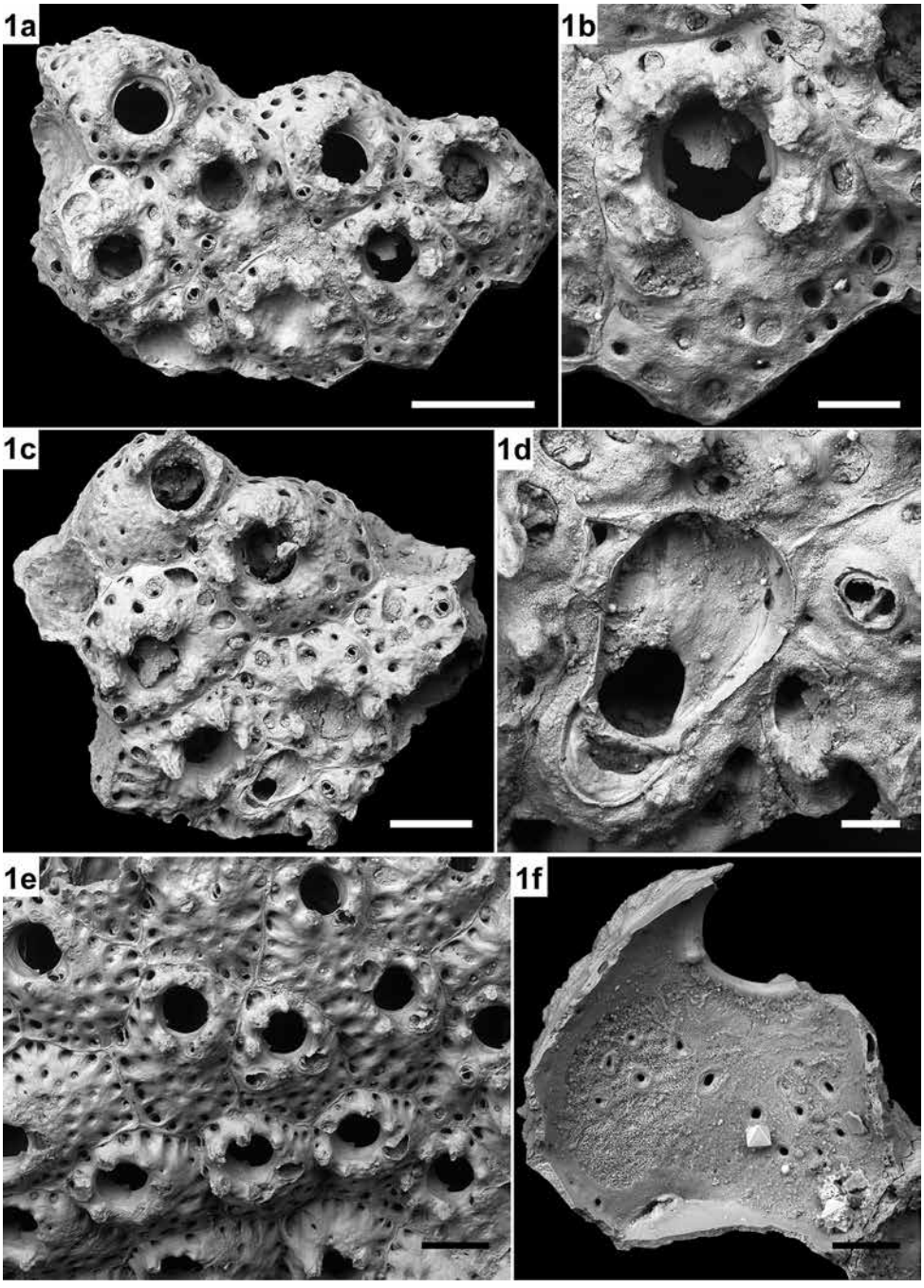


Plate 48

Cigclisula sp. 1
Early Tortonian, TF508, Bontang.
Fig. 1. NHMUK PI BZ 6971. a, part of a bilaminar, branch fragment; scale bar = 300 μm. b, orifice and suboral avicularium; scale bar = 50 μm. c, two autozooids; scale bar = 150 μm. d, primary orifice and suboral avicularium; scale bar = 50 μm.

Plate 49 ▶

Cigclisula sp. 2
Early Tortonian, TF508, Bontang.
Fig. 1. a-b, NHMUK PI BZ 6972. a, colony fragment; scale bar = 500 μm. b, autozooid showing the primary orifice; scale bar = 100 μm. c-d, NHMUK PI BZ 6973. c, colony fragment; scale bar = 200 μm. d, spatulate vicarious avicularium and small, pear-shaped adventitious avicularium; scale bar = 50 μm. e-f, NHMUK PI BZ 6974. e, group of autozooids; scale bar = 150 μm. f, inner view of the pseudoporous frontal shield (upper-right orifice broken); scale bar = 50 μm.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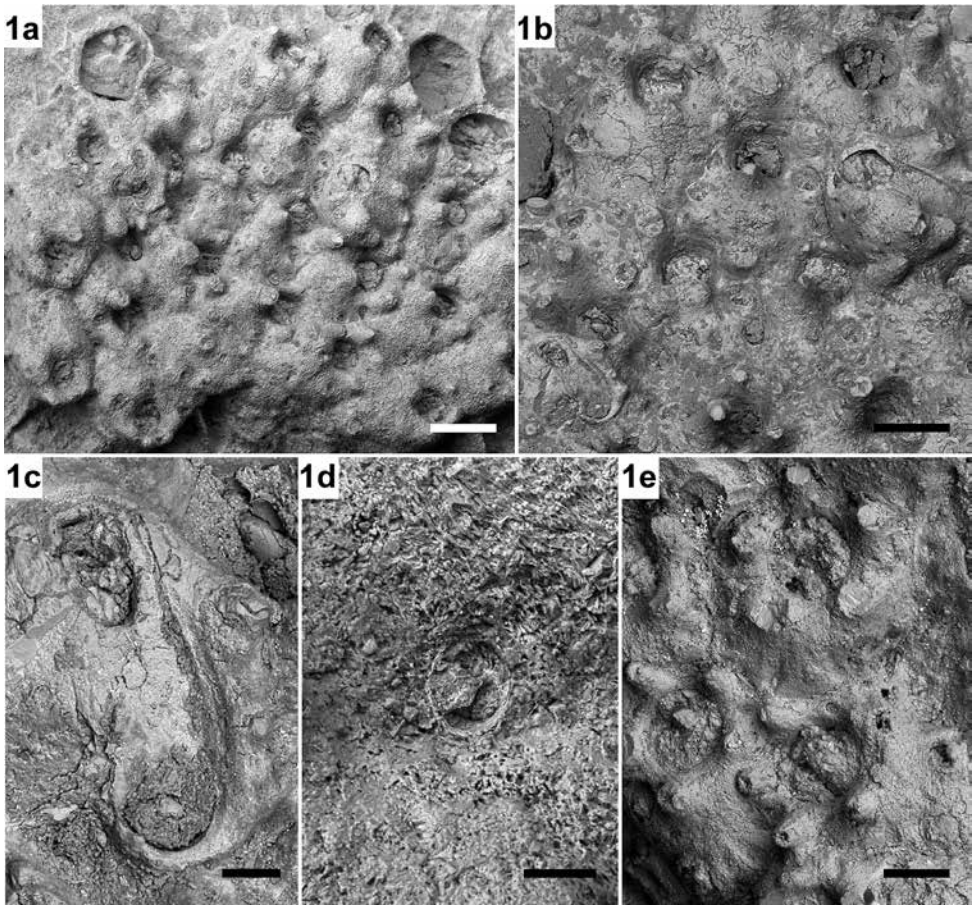


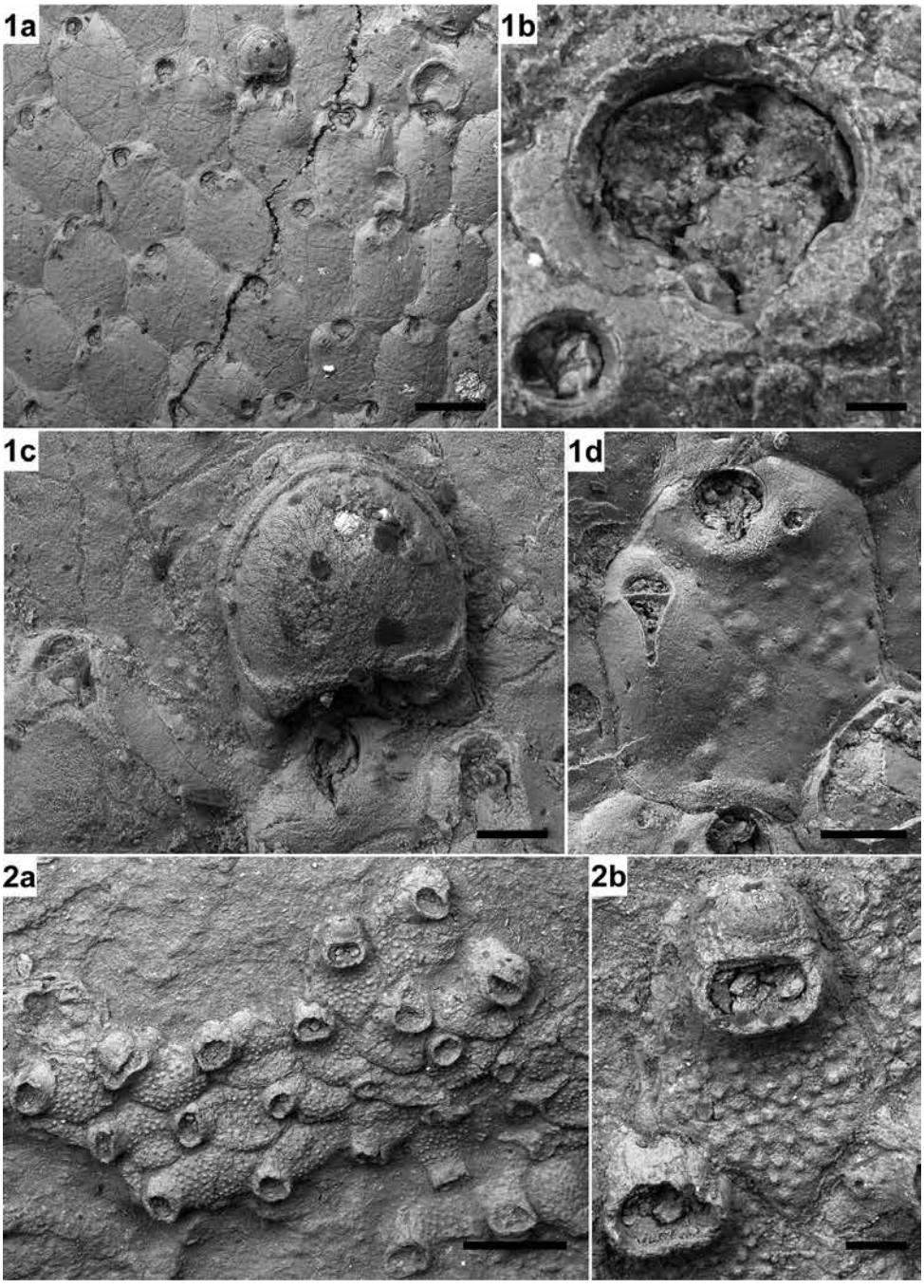
Plate 50

Trematooecia sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6975. a, view of the colony; scale bar = 250 μm. b, group of autozooids; scale bar = 150 μm. c, vicarious avicularium; scale bar = 100 μm. d, adventitious avicularium; scale bar = 50 μm. e, three autozooids; scale bar = 100 μm.

Plate 51 ▶

Buffonellaria sagittaria sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. a-c, Holotype, NHMUK PI BZ 6976. a, view of the colony; scale bar = 300 μm. b, orifice; scale bar = 20 μm. c, ooecium and avicularium; scale bar = 50 μm. d, Paratype, NHMUK PI BZ 6977, zooid and avicularium; scale bar = 100 μm.

Lagenipora sciutoi sp. nov.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6978. a, view of the colony; scale bar = 500 μm. b, ovicellate zooid; scale bar = 100 μm.


1a
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1c
1d
2a
2b

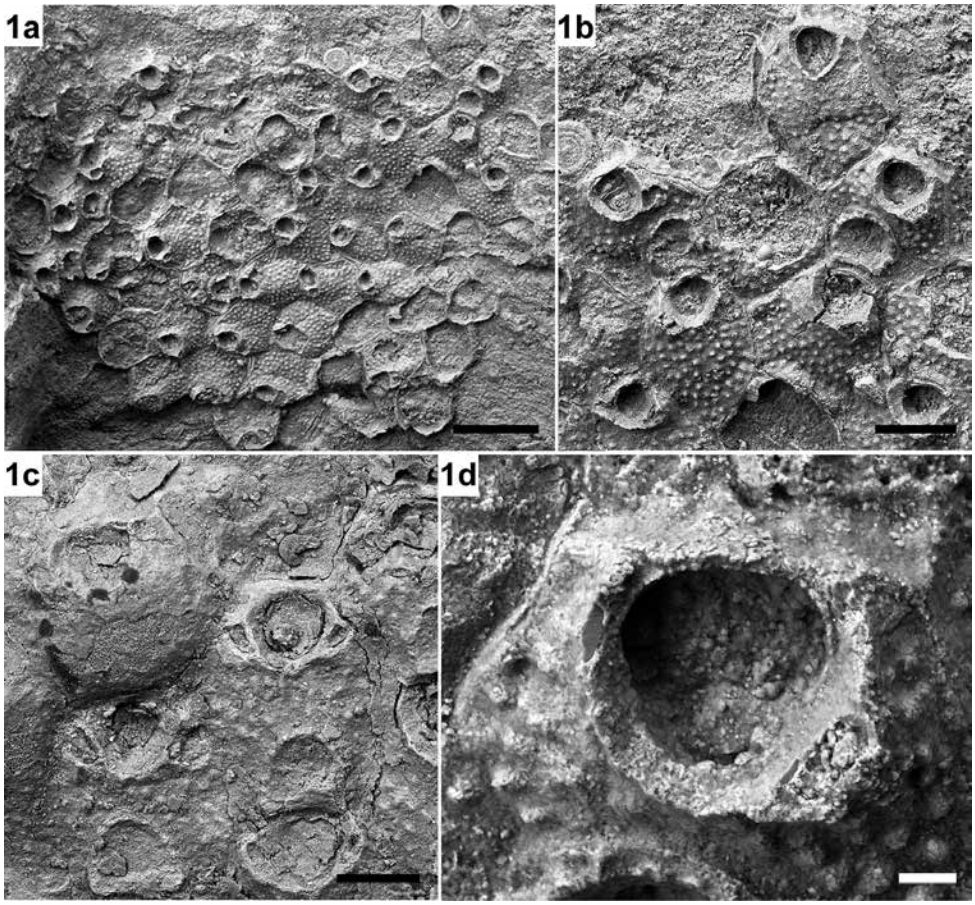


Plate 52

Predanophora sp.
Serravallian, TF59, 'Southern Hemisphere', Bontang.
Fig. 1. NHMUK PI BZ 6979. a, view of the colony; scale bar = 500 μm. b, group of autozooids and ovicellate zooids with broken ooecia; scale bar = 150 μm. c, autozooid with paired, latero-oral avicularia; scale bar = 100 μm. d, orifice and peristome bearing a small avicularium; scale bar = 20 μm.

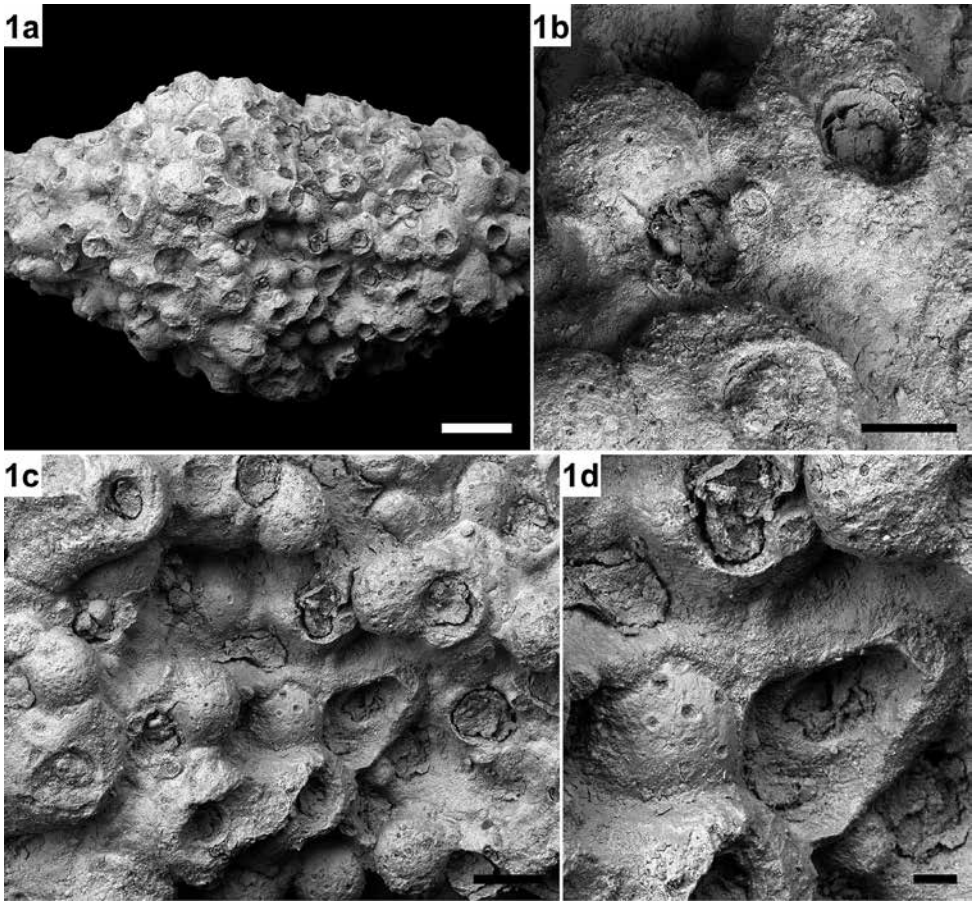


Plate 53

Turbicellepora aff. *canui* Guha & Gopikrishna, 2007
Serravallian, TF76, 'Batu Putih 1', Samarinda.
Fig. 1. NHMUK PI BZ 6980. a, mound-like colony; scale bar = 500 μm. b, two ovicellate zooids; scale bar = 100 μm. c, ovicellate zooids and spatulate vicarious avicularium; scale bar = 150 μm. d, orifice and vicarious avicularium; scale bar = 50 μm.

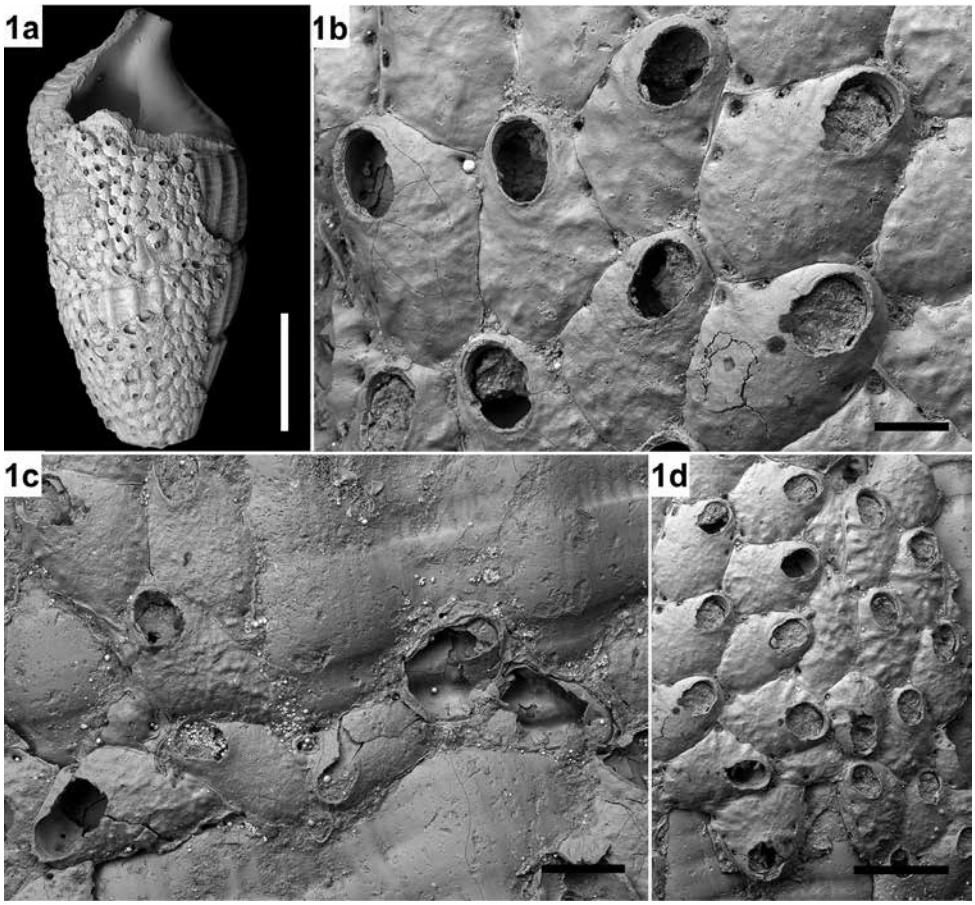


Plate 54

Scorpiodinipora cf. *costulata* (Canu & Bassler, 1929)
Early Tortonian, TF508, Bontang.
Fig. 1. NHMUK PI BZ 6981. a, colony encrusting a gastropod shell; scale bar = 2 mm. b, group of autozooids; scale bar = 100 μm. c, ancestrula and early astogeny; scale bar = 150 μm. d, group of autozooids and kenozooids; scale bar = 300 μm.

Plate 55 ▶

?*Lifuella* sp. 1
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6982. a, group of ovicellate and non-ovicellate zooids; scale bar = 150 μm. b, autozooid with oval latero-oral avicularium and an ooecium; scale bar = 50 μm. c, late zooids with broken ooecia; scale bar = 100 μm.

?*Lifuella* sp. 2
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 2. NHMUK PI BZ 6983. a, group of autozooids with frontal avicularium; scale bar = 150 μm. b, group of autozooids with or without frontal avicularia; scale bar = 100 μm. c, autozooid; scale bar = 100 μm.

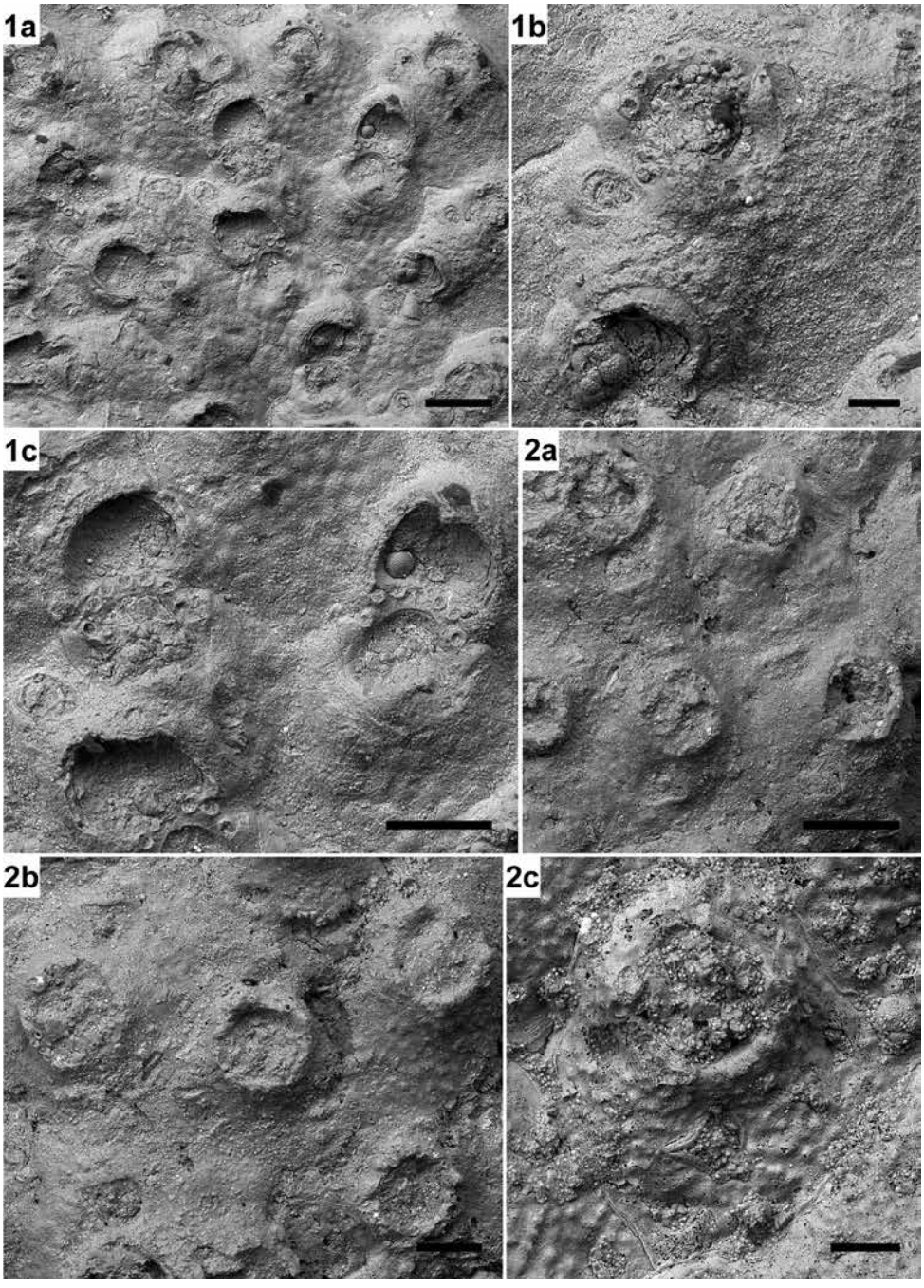
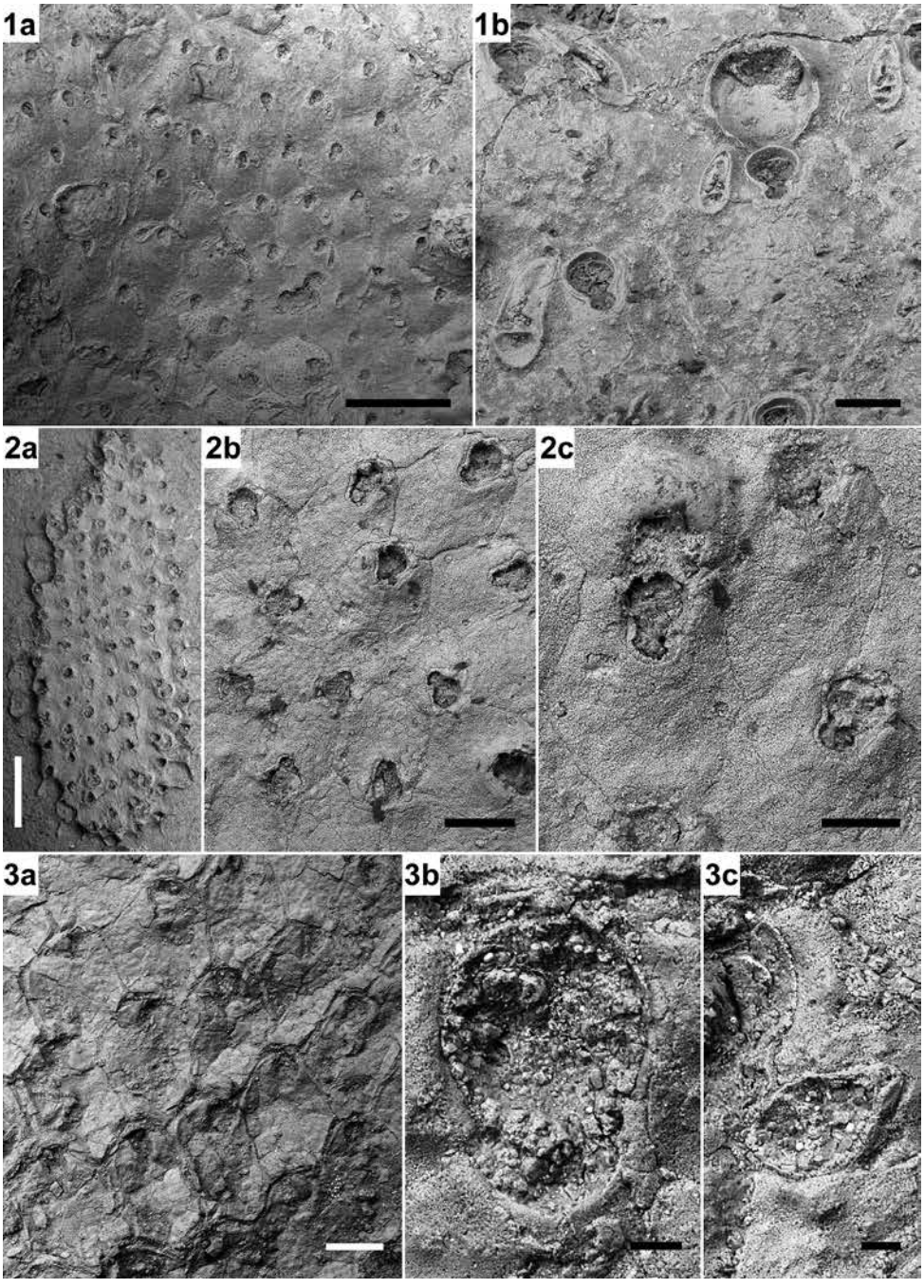

1a
1b
1c
2a
2b
2c

Plate 56

Plesiocleidochasma cf. *laterale* (Harmer, 1957)
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6984. a, view of part of the colony; scale bar = 1 mm. b, zooids showing cleithridiate orifices, adventitious avicularia varying in size, and a broken ooecium; scale bar = 50 μm.

Plesiocleidochasma sp. 1
Serravallian, TF522, 'Coalindo Haulage Road 1', Sangkulirang.
Fig. 2. NHMUK PI BZ 6985. a, view of the colony; scale bar = 1 mm. b, ancestrula and early astogeny; scale bar = 150 μm. c, an ovicellate zooid and non-ovicellate autozooids with five oral spine bases; scale bar = 100 μm.

Plesiocleidochasma sp. 2
Messinian, TF 518, 'Kampung Narut', Sangkulirang.
Fig. 3. NHMUK PI BZ 6986. a, group of autozooids; scale bar = 200 μm. b, orifice; scale bar = 20 μm. c, adventitious avicularium; scale bar = 20 μm.


1a
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2c
3a
3b
3c

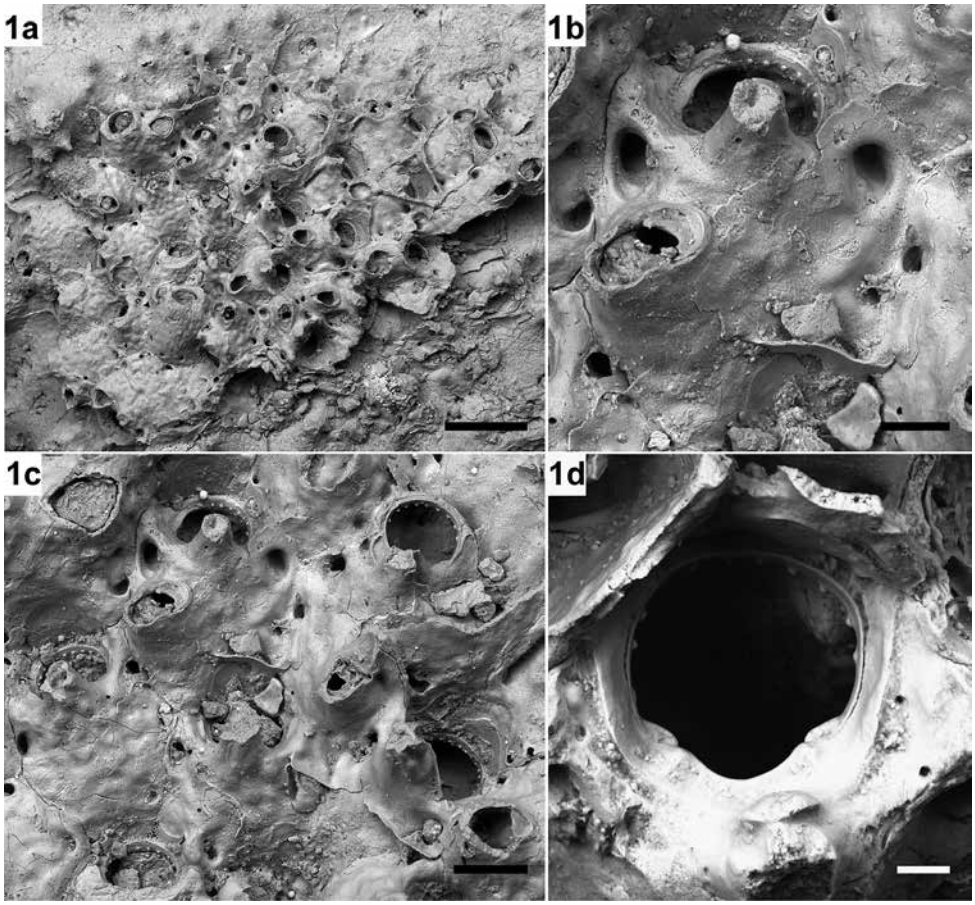

Plate 57

Rhynchozoon sp.
Early Tortonian, TF 508, Bontang.
Fig. 1. NHMUK PI BZ 6987. a, view of the colony; scale bar = 250 μm. b, autozooid showing large, frontal avicularium, suboral umbo, denticulate anter and oral spine bases; scale bar = 50 μm. c, group of autozooids; scale bar = 100 μm. d, primary orifice; scale bar = 20 μm.

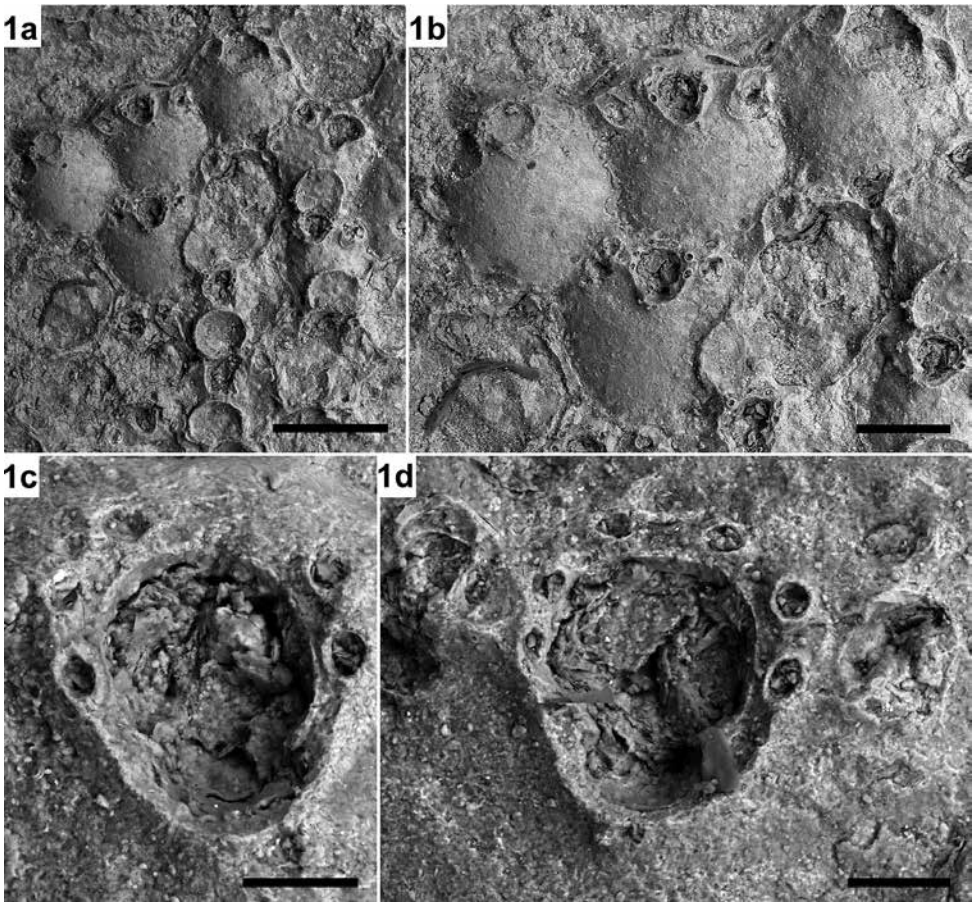

Plate 58

Stephanollona sp.
Late Burdigalian, TF126, '3D Reef', Bontang.
Fig. 1. NHMUK PI BZ 6927. a, part of the colony; scale bar = 500 μm. b, group of autozooids showing basal pore chamber windows at distal edge; scale bar = 200 μm. c-d, orifices with six oral spine bases; scale bar = 50 μm.

Plate 59

Triphyllozoon sp.
Late Burdigalian, TF 126, '3D Reef', Bontang.
Fig. 1. a-d, NHMUK PI BZ 6988. a, frontal view of a branch fragment; scale bar = 500 μm. b, two, flask-shaped autozooids showing frontal avicularium and deep, teardrop-shaped sinus; scale bar = 100 μm. c, close-up of a peristome of an ovicellate zooid (top right) with only two oral spine bases, and a peristome of a non-ovicellate zooid with four oral spine bases; note the proximal denticulation; scale bar = 100 μm. d, ovicellate zooids lacking suboral avicularia; scale bar = 100 μm. e, NHMUK PI BZ 6989, ovicellate zooids with two types of suboral avicularia; scale bar = 50 μm. f-g, NHMUK PI BZ 6990. f, ooecium; scale bar = 25 μm. g, ooecium with trilobate frontal suture; scale bar = 25 μm. h-i, NHMUK PI BZ 6991. h, abfrontal view of a branch fragment; scale bar = 500 μm. i, close-up of the abfrontal side; scale bar = 100 μm.

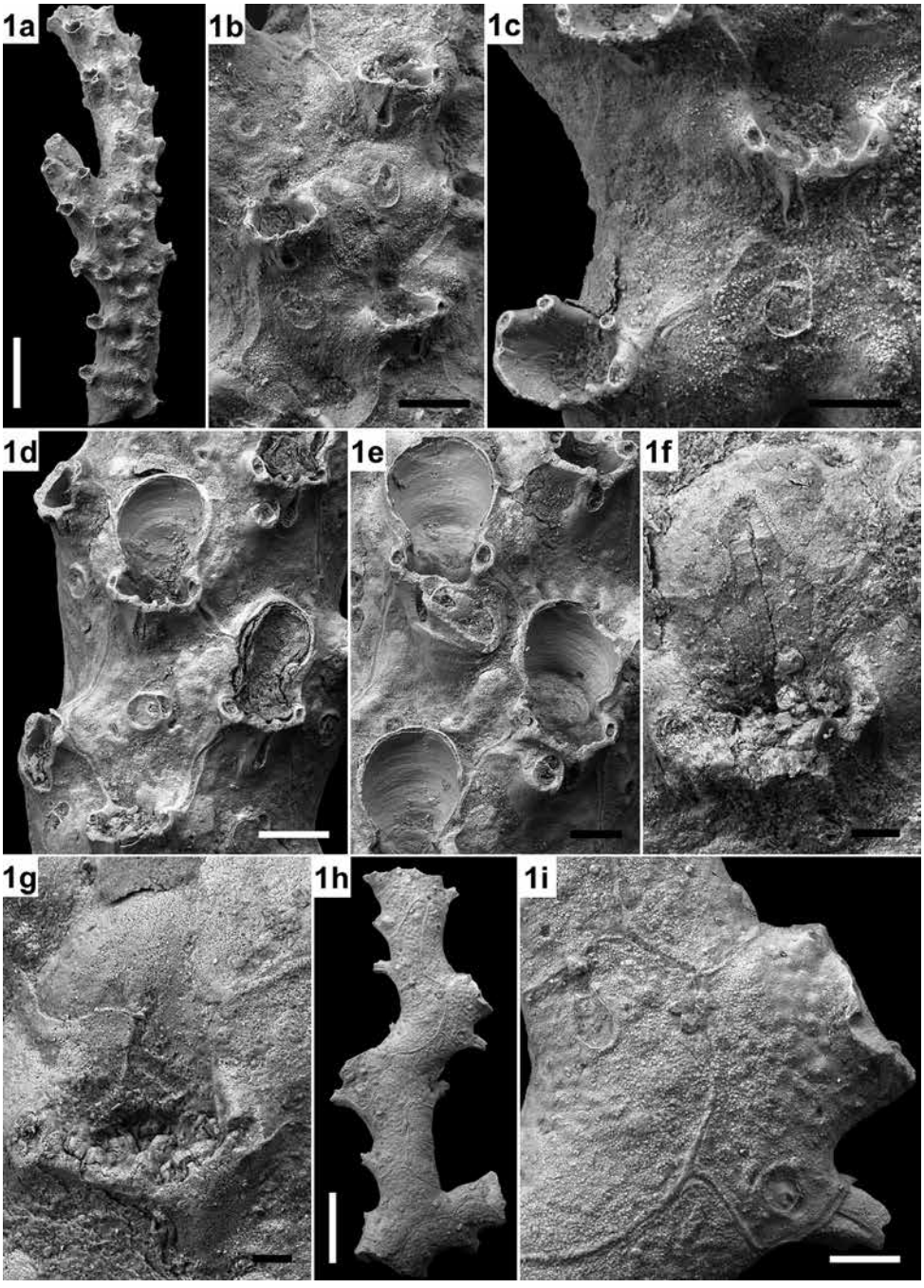
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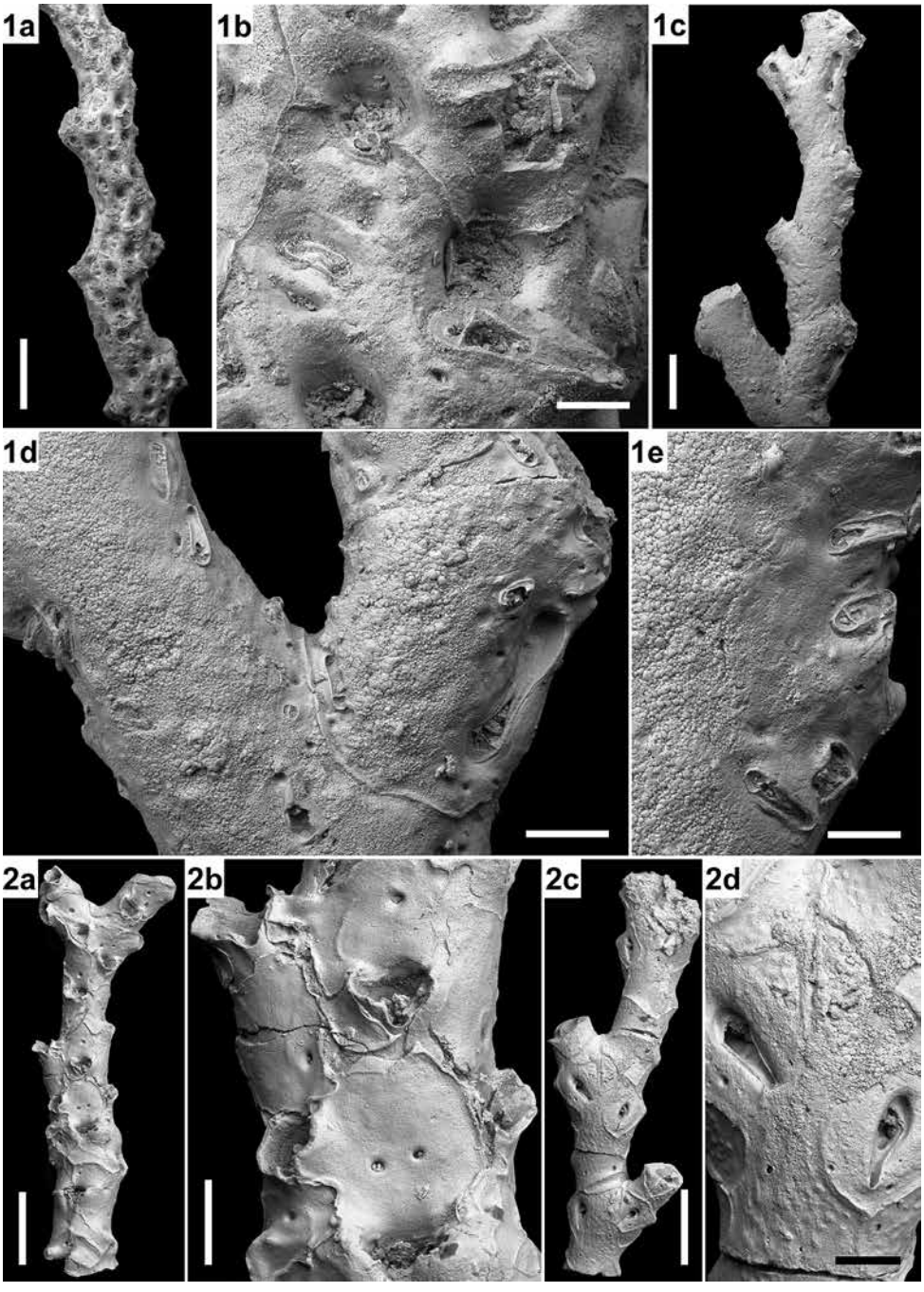
Plate 60

Phidoloporidae sp. 1
Late Burdigalian, TF 126, '3D Reef', Bontang.
Fig. 1. a-b, NHMUK PI BZ 6992. a, frontal view of a branch fragment; scale bar = 500 μm. b, autozooids showing different types of suboral and frontal avicularia; scale bar = 100 μm. c-e, NHMUK PI BZ 6993. c, abfrontal view of a branch fragment; scale bar = 500 μm. d, close-up of the abfrontal side at a bifurcation showing three different types of avicularia; scale bar = 150 μm. e, oval avicularia at the abfrontal edge; scale bar = 100 μm.

Phidoloporidae sp. 2
Late Burdigalian, TF 126, '3D Reef', Bontang.
Fig. 2. a-b, NHMUK PI BZ 6994. a, frontal view of a branch fragment; scale bar = 350 μm. b, autozooid; scale bar = 100 μm. c-d, NHMUK PI BZ 6995. c, abfrontal view of a branch fragment; scale bar = 300 μm. d, close-up of the abfrontal side with large, triangular avicularia; scale bar = 100 μm.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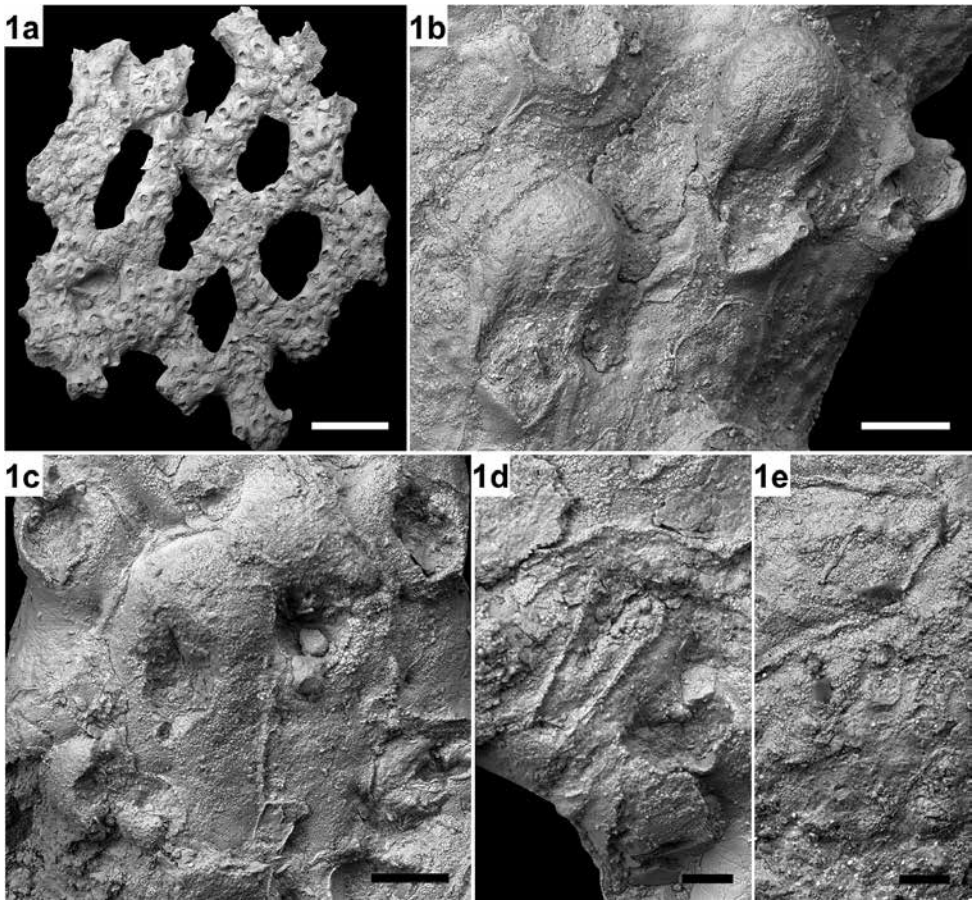

Plate 61

Phidoloporidae sp. 3
Serravallian, TF 76, 'Batu Putih 1', Samarinda.
Fig. 1. a-d, NHMUK PI BZ 6996. a, frontal view of a fenestrate fragment; scale bar = 1 mm. b, ovicellate zooids with a median longitudinal fissure on the ooecia; scale bar = 100 μm. c, ovicellate zooid showing a small, teardrop-shaped, peristomial sinus; scale bar = 100 μm. d, vicarious avicularium at the edge of a fenestrula; scale bar = 50 μm. e, NHMUK PI BZ 6997, close-up of the abfrontal surface; scale bar = 20 μm.